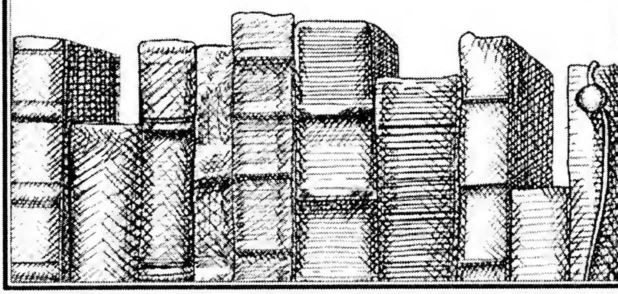

AN

ESSAY

TOWARDS A

SYSTEM

OF

MINERALOGY.

AN ESSAY TOWARDS A SYSTEM OF MINERALOGY:

BY

AXEL FREDRIC CRONSTEDT.

Tranſlated from the Original Swediſh, with NOTES,

By GUSTAV VON ENGESTROM.

TO WHICH IS ADDED, A

Treatiſe on the Pocket-Laboratory,

CONTAINING

An Eaſy Method, uſed by the AUTHOR, for Trying MINERAL BODIES,

WRITTEN BY THE TRANSLATOR.

The Whole Reviſed and Corrected, with ſome Additional Notes,

By EMANUEL MENDES DA COSTA.

LONDON:

Printed for EDWARD and CHARLES DILLY, in the Poultry.

MDCC LXX.

Mr. DA COSTA's

PREFACE.

I Should hardly have troubled the Reader with any Preface, had not the title page mentioned a Tranſlation by Mr. Engeſtrom, reviſed and corrected by me; which neceſſarily demands ſome explanation, in juſtice to us both. It is as follows:

Mr. Engeſtrom, a Swediſh gentleman of great merit and learning, particularly in the ſcience of Mineralogy, amuſed himſelf with tranſlating Mr. Cronſtedt's celebrated *Syſtem of Mineralogy*.

On Mr. Engeſtrom's return to Sweden, this tranſlation became the property of Meſſieurs Dilly, by whom I was employed to reviſe and correct it; as it could not be expected that Mr. Engeſtrom, being a foreigner, was capable of giving a correct tranſlation in regard to language, or to a proper application of ſcientifical names.

I have therefore carefully corrected it in thoſe particulars, and collated it with the German edition printed at Copenhagen in 1760; and the notes which occurred to me I have marked with D. C. to diſtinguiſh them from thoſe of Mr. Engeſtrom, marked E.

THE

TRANSLATOR's

PREFACE.

THIS Eſſay was publiſhed in Swediſh in the year 1758, by the Author, who in the beginning choſe to be anonymous, for reaſons he has given in his Preface: He could not, however, remain long concealed, but was ſoon diſcovered to be the learned nobleman Axel Fredric Cronſtedt. I now give a tranſlation of it, to comply with the deſire of ſeveral of my friends here in England. I ſhall not attempt to amuſe the Publick in favour of this work, ſince it ſpeaks ſo well for itſelf, and has been almoſt generally adopted wherever known.

The univerſal applauſe, and the favourable reception it met with in Sweden, made it ſoon known in Norway and Denmark. In the year 1760 it was tranſlated into German, and was equally

equally approved in Germany; nor, indeed, has it been unknown to the learned in England; for the ingenious and celebrated Dr. Lewis has mentioned it with praiſe in the ſecond part of his Philoſophical Commerce of Arts lately publiſhed.

As a foreigner I ſhould make an excuſe for the tranſlation, it not being ſo elegant as it ought to be; however, I flatter myſelf I ſhall not be too ſeverely cenſured on that account, ſince it is a known truth, that originals always loſe ſomething of their beauty by being tranſlated: I therefore think it better to prefer the true meaning of authors to the elegancy of ſtile, particularly in ſcientifical works; and I am in this reſpect more able to give the Public ſatisfaction, as I have had the happineſs to be a diſciple of the author himſelf.

That the mineralogical terms might be more generally underſtood, I have added the Swediſh and German names of the mineral bodies to their Engliſh and Latin names; except when to avoid tautology I have ſometimes left out the German as nowiſe different from the Swediſh names. New diſcoveries being daily made in this ſcience, I have alſo added ſome notes of my own, concerning ſuch things of which I am perfectly convinced, leaving ſeveral others to be further examined and tried.

I was in hopes to have ſeen a ſecond edition of this excellent work improved and augmented by the author himſelf; he having, ever ſince the firſt publication of it, been conſtantly employed in making further enquiries and diſcoveries in this ſcience: He had even actually made ſome collections towards it, of which, however, the literary world is likely to be unfortunately deprived, as he lately died in the fortieth year of his age, before he had time to reviſe and put his new obſervations in due order.

THE AUTHOR's PREFACE.

AS former ages principally encouraged philological and antiquarian enquiries; this present age, at least in Sweden, favours the study of Natural History.

Such changes must be ascribed to geniuses, who understand how to make those sciences, which they have chose for their principal study, agreeable to the Public; and which Sciences, being in general useful to the whole community, every individual thereof can reap some advantage from it, and thereby gratify that self-love implanted in the breast of all mankind in the pursuit of them.

When the pride of a nation is flattered with the vain glory of being of great antiquity, the author of such an opinion is always favoured; and every little circumstance conducive to further confirm it, is carefully recollected and noted. Thus when the subjects of the creation are represented to us in a manner which assists our memory, and renders our conceptions of them easier, we aim at earnestly adopting the noble improvement, and, in order to be the more esteemed, we likewise always confer praise on the author.

As long as the author adheres to his system, and does not alter it, but only illustrates it from time to time with some additional observations, we are not only well satisfied with him, but also often become his faithful assistants. But if he, convinced of the impropriety of his method from its very principles, rejects it, and presents us with another new and entirely different; what will then be the result? Or what is likely to happen if this is attempted by a person who is unknown, and not artful enough to seize on the advantages of our passions?

For my part, I am apt to believe, that in the former case, the present general taste might be somewhat lessened without any loss to the science itself; because among the great number that love Natural History, there are always some who embrace it when free from errors, and others, who are only fond of new reasonings and conclusions, merely because they are so.

These latter are even of service, and their party will certainly increase in length of time.

From this persuasion I have ventured to publish this Essay for treating Mineralogy in a systematical manner; a study to which I have with so much pleasure applied myself. It is not done from the desire of novelty; and still

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leſs from contempt of thoſe ſyſtems, which Swediſh gentlemen in particular, very deſervedly, though chiefly on the ſame principles, have heretofore generally purſued.

I have thought proper to conceal my name *, to prevent any conſtraint on myſelf or others, and with a view to be at a greater liberty to amend the Syſtem, whenever I ſhall be convinced there is a neceſſity for ſo doing, either by my own experience, or by the obſervations of others: For I flatter myſelf that this work will not paſs unnoticed by men of letters; and, as it is only an Eſſay, it ought, according to an eſtabliſhed law amongſt authors, to be ſheltered from too ſevere cenſures.

I wiſh that the mineraliſts themſelves would examine and compare all that has been hitherto done in this ſcience; they would then find the reaſon which has induced me to deviate from the received ſyſtems, and to propoſe another founded upon my own, as well as upon the diſcoveries of others. But as this compariſon is not in the power of every one to make, I think it neceſſary briefly to repeat here the changes which this ſcience has undergone.

The firſt writers on Natural Hiſtory found ſo great a number of unknown bodies before them, that their curioſity and time would not allow them to do more than to deſcribe them by their mere external appearances, and to collect the names by which they were known to the natives of the countries where they were

* Mr. Cronſtedt never put his name to this Eſſay. D. C.

found. But as every country had a different name for these bodies, they often gained more names than there were real ſpecies, and even ſometimes the very reverſe happened; this occaſioned a confuſion, which in the beginning was excuſable, but in length of time could not fail of being an obſtacle to the progreſs of the ſcience, and its application in common life.

To remove and alter theſe inconveniences, they have in later and more enlightened times endeavoured to fix proper names to the ſubjects of the mineral kingdom, according to their external marks, as in regard to Figure, Colour, and Hardneſs; but theſe characters afterwards having been found not ſufficient, it was neceſſary to diſcover others more ſolid by the reſult of chemical experiments, which added to the former ones would make a complete ſyſtem. Hiarne and Bromell were, as far as I know, the firſt who founded any mineral ſyſtem upon chemical principles. However, they were only the projectors of this manner of proceeding; and to them we owe the three known diviſions of the moſt ſimple mineral bodies; viz. the *Calcarei*, *Vitreſcentes*, *et Apyri*. This ſyſtem was afterwards adopted by Dr. Linnæus, who, as a very ſkilful perſon in the other two kingdoms of nature, ought not to have omitted the third when he publiſhed his Syſtema Naturæ. Browal, biſhop of Abo, a prelate of great learning, had an opportunity of altering and improving Linneus's method in a manuſcript, which Dr. Wallerius has ſince made public in his Mineralogy.

logy, with ſome alterations of his own; however, the principal foundation remained the ſame in all, or according to Bromell's method, which he had publiſhed in a ſmall book, entitled *Indications for the ſearching for Minerals*: Until Mr. Pott, a chemiſt by profeſſion, and conſequently inclined rather to believe the effects of his experiments, than the external appearances alone, proceeded farther than was cuſtomary before his time, in the aſſaying of ſtones by fire, and afterwards publiſhed his acquired knowledge by the title of *Lithogeognesia*. From this book the ſaid author received conſiderable honour, becauſe the true advantage of his reſearches began to appear: Miners and other manufacturers were by it able to determine the reaſon of certain effects, which they before either did not obſerve, or wilfully concealed, to avoid the cenſure of being ignorant, if they advanced ſuch things as real truths, which, according to modern ſyſtems were regarded as contradictory and abſurd. Mr. Wolterſdorff, a diſciple of Mr. Pott, then begun *immediately to form an entire mineral ſyſtem*, founded upon chemical experiments; but his maſter did not approve of it, ſtill inſiſting that materials were yet wanting for the purpoſe; and that *every* mineral body ought firſt to be examined and tried with the ſame care that he had tried and examined the moſt ſimple of them; to wit, the Earths and Stones.

Such was, according to the idea I had of it, the ſtate of Mineralogy, when I, touched by

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the difficulties which beginners laboured under, undertook to put my ſcattered thoughts in this order. Naturaliſts agreed with me, in thinking the barrier, which had a long while been defended with ſuch ardour, was now beaten down, and that it was neceſſary another ſhould be erected in its ſtead, as good as could be procured, until a perfect one might be in time diſcovered.

Such an enterprize it was thought would promote this deſirable end, when on one ſide I reflected upon the paſſion which our learned have for diſputing, and on the other part conſidered the gracious reception which the Arts and Sciences have met with at this time, from thoſe to whom the heavy burthen of governing human ſocieties is allotted. It is from their care we are to expect the compleat tribunal where all diſputes in this matter can be accurately decided, and all things be rendered truely uſeful; I mean the inſtitution of a Laboratory; where the ſight, grinding and poliſhing; where the air, liquid, and dry diſſolvents and alſo fire in all its degrees, from the electrical to that of the burning-glaſs, may be employed as means to obtain the knowledge of theſe intricate and unknown bodies.

To a ſimilar circumſtance, perhaps, thoſe chemical experiments upon vegetables were owing, which were made many years ago in a certain kingdom; and though they did not anſwer at that time the intended purpoſe, yet they may at ſome future time be repeated with advantage,

advantage, when more knowledge in that matter is obtained: But thus much we certainly know by experience, that the mineral kingdom is extremely well adapted to be examined by these means. The experiments made by the ingenious Mr. Homberg, with Tſchirnhauſen's burning-glaſs, may certainly be carried yet farther, whereby ſome doubts may likewiſe be removed, which ſtill remain regarding ſome of the effects of his experiments. Thus, we ſhould be employed in obſerving the phœnomena and drawing concluſions from them, inſtead of only ſearching for the principles of thoſe effects, as naturaliſts were formerly obliged to do.

How ſatisfied would every lover of ſyſtems be, if by this means he could get materials properly prepared to compoſe a better work, in which he could introduce the few valuable things which are to be found among the old ruins, and leave out all the vague expreſſions, together with the diſtinctions, that are of no conſequence.

When I had, for the above-mentioned purpoſe, collected my own obſervations, and thoſe of others, I heard of two new books on the ſame ſubject; they were Mr. D'Argenville's Oryctology, and Mr. Juſti's Mineralogy; for which reaſon I laid my manuſcript aſide, until I had, by the peruſal of thoſe two works, convinced myſelf that thoſe gentlemen had not prevented me from purſuing my plan; for, the former has, in my opinion, endeavoured to bring us back to a tafte that was formerly in vogue; and which, though we do not defpife, *yet we neglect.* The fecond feems to have hurried himfelf too much, mixing together fome irrefiftable truths, with a greater number of opinions, not yet demonftrated, or mere conjectures; *which is running on fafter with a theory than experiments will permit*; whereby nature, which is the *chief point*, will at the end be loft.

Therefore, that no fondnefs for novelties, in confequence of thefe new works, or others of the like nature, which may hereafter be publifhed, may again divert our attention from the *only method of obtaining any knowledge of the Mineral Kingdom*, which has with fo much pains at length been difcovered, and has already been a little entered upon; I have, prompted either by felf-love, or a more generous motive, publifhed this Effay, even before I have had time and leifure to reduce it into a perfect fyftem: I do not pretend that it is a compleat one, by which we can with certainty divide mineral fubftances, and afterwards reduce them into order. I have chiefly intended it as a bar or oppofition to thofe, who imagine it to be an eafy matter to invent a method in this fcience, and who, *entirely taken up with the furface of things*, think that the *Mineral Kingdom may with the fame facility be reduced into claffes, genera, and fpecies*, as *animals* and *vegetables* are; they do not confider that in the two laft kingdoms of nature there are but feldom,

dom, and never more than two different kinds found mixed together in one body; whereas in the mineral kingdom it is very common, though it will neverthelefs always remain concealed from every one, however penetrating, *who has not employed himfelf in the compounding or decompounding fuch bodies*, as far as the prefent knowledge of thefe matters will permit.

So much may be faid in general concerning this Effay; but now I ought more particularly to inform my readers of the motives why I have now and then deviated from the orders and diftinctions hitherto ufed.

Earths and Stones are comprehended in one clafs, becaufe 1. they confift of the fame principles; 2. they are by turns converted from one into the other, infomuch that an earth may in length of time become as hard as a ftone, and *vice verfa;* nor can the true difference between a ftone and an earth be pofitively pointed out by the degrees of hardnefs or foftnefs; for where is it that the common chalk finifhes, and the lime-ftone begins in the Englifh ftrata? and how is a clay, whether in water or not, to be diftinguifhed from the foft and unctuous foap-rock, or Smectis.

The divifion of earths into *Vitrefcentes* and *Apyri* is here omitted, fince all of them are, in a due degree of heat, found equally apt, either *per fe*, or by means of fome natural or artificial mixture, to be reduced to glafs equally as well as thofe hitherto called *Vitrefcentes*; which are nearly the moft refractory in the fire, and ought to be called *Vitrescentes cum alcali*, if their name was to have any connection with their effects.

Having now so far overcome the former ignorance, which was the foundation of the knowledge for distinguishing the mineral bodies into transparent or opaque, hard or soft, we prefer the decision of the fire, though we still labour under the misfortune of not being able to measure the degrees of fire with sufficient accuracy; for which reason we always must suppose a *plus ultra* in the experiments by fire.

Sand in reality is nothing else than very small stones; therefore, if a separate class were to be made of Sands, another class ought to be made, which should comprehend Gravel; a third, Loose Stones; and a fourth, Mountains: This would be a *multiplicatio entium præter necessitatem*; a fault, which under these circumstances may easily be committed, though not so soon perceived.

The Saxa must for the same reason be excluded from any system: Otherwise it would be the same as if a botanist made a difference between the misletoes, or such like vegetables, according to the different genera or species of trees, plants, walls, or rails on which they grew.

Petrefactions, or *Mineralia larvata*, consist of such principles as ought to be described in their proper places, without regard to their figure; for which reason they cannot be enumerated a second time. The principal reason for collecting them, is to acquire a knowledge of such bodies of the animal and vegetable king-

doms,

doms, as are not uſually found in their natural ſtate, and in this reſpect they belong properly to the ſtudies of the Botaniſts and Zoologiſts. For a Mineraliſt is ſatisfied with a ſingle ſpecimen of each different ſubſtance that has taken the ſhape of a vegetable or animal body, and this only to illuſtrate the hiſtory of their generation; he leaves it to others to decide if corals are vegetables, or the habitations of worms; and thus receives them very unconcernedly, after they have been mouldered to a chalk, changed into a ſpar, or into any other ſtony matter. Nevertheleſs, I have in the Appendix propoſed a method for ranging the *Saxa* and *Petrefacta* in regard to the œconomical uſes that may be expected from them.

Slate ſignifies or denotes the form alone, and not its kind or qualities; however, it regards only its ſituation in the rock, and not the texture of its particles; which latter I have always endeavoured to take notice of, ſince ſome difference in the effects frequently depends on it. And, as nothing is great or ſmall but by compariſon, it is difficult ſtrictly to determine in what degree of thickneſs or thinneſs a ſtone begins to deſerve the name of a ſlate. Nevertheleſs, I would have prevailed on myſelf to adopt this general name, if the breaking in thin plates had been the property only of any particular kind of ſtone, but it is by no means the caſe; becauſe there is found in the province of Jemteland, in Sweden, a pure quartz, limeſtone, (both ſolid and ſcaly) indurated

rated boles, alum ores, and a great number of ſaxa, which are all of a plated ſtructure, dividing into leaves as thin as paſteboard: And therefore I make no doubt but all kinds of ſtones may be found of ſuch a figure in ſome parts of the world. What confuſion would it not occaſion if all theſe different kinds were included under one genus? And are there not ſolid ſtones found conſiſting of the ſame conſtituent parts as the ſlates, which are ſeparately conſidered in ſyſtems?

I could not range the ores according to the different kinds of rock in which they are found; for inſtance, the Gooſe-dung ſilver ore, the Liver ore, and many more of the ſame kind, ſince obſervations upon the matrices of ores belongs to another branch of the Mineral Science, called *Geographia ſubterranea*, or *Coſmographia ſpecialis*; in which likewiſe the clefts, fiſſures, and veins or loads, that occur in every ſort of rock, (in order to promote the circulation and fixation of the mineral vapours) are treated of. In that Science alſo the *Petræ Paraſiticæ* are pointed out, whoſe number perhaps is not yet known; as likewiſe the gloſſy fiſſures from which the *Mineræ Speculares* have obtained their name. And this is a branch of ſcience, which, in the hands of a ſkilful mineraliſt, is likely to furniſh us with a perfect idea of the age of every ſort of ſtone, and alſo of their different gradations between the two accidents, to which all created beings are ſubject, Compoſition and Deſtruction.

Since it has not been usual to consider the earths and stones as the same, in regard to the principles of which they consist, and only different from one another by the greater or lesser hardness and coherency of their particles; I hope for excuse, in not being able to prosecute this Essay so far as to point out a particular earth for each kind of stone. Perhaps also some of the mineral bodies are already so much hardened, that no earths of this kind are to be found; or, perhaps, the little knowledge we have of them is owing to the neglect of not collecting earths with the same earnestness as we do stones and ores. If, therefore, all the earths which are ranged in certain modern systems, and there distinguished from one another, in regard to the difference of their colours and places where they are found, had fallen into the hands of Mr. Pott, and been tried by him in the fire, as he has tried the stones, and been described in his *Lithogeognesia*, it is very probable that we now should know these bodies better, and their number would certainly be less perplexing.

The hints which are here given may, however, tend to promote the intended point for the future; and then perhaps the earths will be found not to be quite of so many different kinds as I have here been obliged to divide them into, for want of perfectly knowing their affinities and their several origins; because we have strong reasons to believe that the calcareous and argillaceous earths are the two principal ones, of which all the reſt are compounded, although this cannot yet be perfectly proved to a demonſtration.

The *Luſi Naturæ* are not ſeparately treated herein; they may be found every where in the Eſſay, becauſe the rock cryſtals do not appear to me leſs curious than the indurated marles; and the kidney ore is often found of a more ſurpriſing figure than the eagle-ſtone. I cannot therefore find any reaſon for forming a claſs of them, nor do I comprehend what others take to be a greater or leſs ſport of nature in the mineral kingdom.

Figured ſtones, or which contain the repreſentations of vegetables, animals, &c. occaſioned by different veins or colours in the ſtones, are in my opinion of ſtill leſs conſequence, and are alſo more difficult to range properly in claſſes; becauſe people ſeldom, or rather never, agree in their fancies; but what ſeems to repreſent an object to one, may make a different appearance in the imagination of another, whereby both confuſion and diſputes would ariſe about the bodies of ſuch a claſs. Beſides, a very ſmall advantage, if any, can reſult from ſuch a claſs; ſince all that the Almighty created has required equally his power, and is alſo equally worthy of our admiration: It gives rather riſe to pedantry, whereby the attention is by degrees diverted from true knowledge to mere trifles, of which both ancient and modern books are ſad inſtances; and if Mr. Du Fay had not impeded the evil by diſcovering the method of improving the figures upon flints and agats, we might ſtill have ſeen whole collections full of them with ſuch imaginary figures.

Stones that are found in animals and fiſhes, are partly compounded of phlogiſton, ſalts, and a ſmall quantity of earth, and partly conſiſt of the ſame matter with animal bones, and can therefore with as little reaſon have a place in a mineral ſyſtem as the ſtones of fruits. Soot, tartar, yeaſt, and things of ſuch nature, have too great affinity to the vegetable kingdom, and are never to be met with under the ſurface of the earth; wherefore they may in Botany be conſidered in the ſame manner as regules, glaſſes, and ſlags are in Mineralogy.

The hair-balls found in animals, and felt, differ from one another in that the former are worked together by means of the periſtaltic motion in the bowels of the animals, and the latter by the art of the feltmonger. May not all theſe ſtones of animals therefore be ranked among the *relicta animalia?*

By all this it is very evident, that my chief care has been to treat the mineral kingdom in ſuch a manner, that thoſe whoſe principal ſtudy it is, may avoid every thing unneceſſary and ſuperfluous; and by a perfect knowledge of the ſubjects be brought to conſider how to employ them to the beſt advantage; whereby I hope that the pleaſure of collecting minerals will rather encreaſe than be diſcouraged. If ſome objects are thrown out from mineral collections on account they do

 not

not belong to them, other collections will be augmented; and thus every thing will be brought into a due order. If some collectors should not immediately be able to comprehend this System or Classification, it cannot much detriment the science; and it is likewise of very little consequence in proportion to the advantage that will accrue to the study by this method, the more it shall be cultivated and improved.

Ptolomy cannot be supposed to have known the value of every book he sent to his great library in Alexandria, and he had doubtless no time to class them himself according to the contents of the different books acquired; however, his love for collecting must have continued during his life: Moreover, the advantages obtainable from it would have been afterwards discovered, had it not been dispersed; or, as sometimes happens, had not the collection been supposed to gain some additional value by being made difficult of access to the learned.

As soon as we are arrived to such a pitch, as by the examination of a mineral body to discover or know all its constituent parts, and can assert with certainty that it can be no further decompounded by any method hitherto known; then such a body ought, according to the intention of this Essay, to receive its specific name, and not before; for otherwise it will be vague and trivial. However, I have not assumed a confidence to do this even with such mineral bodies that I in some respect can aver

I pretty well know, and which have not yet obtained any fixed name; as I think it proper to wait that event, until this Eſſay has paſſed through that trial which I ſincerely wiſh it deſerves to undergo, equally with others of the ſame nature. Then only will be the proper time to fix the genera and ſpecies, according to ſuch characters as ſhall be found the moſt natural.

Meanwhile I flatter myſelf with ſo much ſucceſs, that ſtudents, who intend to follow this propoſed method, will not be ſo eaſily miſtaken in the ſubjects of the mineral kingdom, as has happened with me and others in following former ſyſtems; and I alſo hope to obtain ſome protectors againſt thoſe who are ſo poſſeſſed with the *figuromania*, and *ſo addicted to the ſurface of things*, that they are ſhocked at the boldneſs of calling a *Marble* a *Limeſtone*, and *of placing the Porphyry amongſt the Saxa.*

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ERRATA.

ERRATA.

Page 18, line 25, read, *Of pyramidal*, &c.
—— 26, —— 3, for *Drusea*, read *Drusæ*.
—— 27, *Antepenultimate line* for *Gypsea*, read *Gypsæ*.
—— 38, —— 32, read *calcareous earth*, &c.
—— 58, —— 31, for *Sect*. I. read *Sect*. L.
—— 67, —— 12, for *Sardea*, read *Sarda*.
——106, —— 21, for *Smelling*, read *Smelting*.
——224,—— 4, read, *Of the others*, &c.
In Sig. T, for p. 173—188, read 273—288.

ESSAY

TOWARDS A

SYSTEM

OF THE

MINERAL KINGDOM.

SECTION I.

THE Mineral Kingdom contains all thoſe bodies which have been formed under the ſurface of our earth, whether at the firſt creation, or any other time ſince that period; and which are ſtill daily produced from their original or primary principles, being deſtitute of ſeed, life, or any circulation of fluids *.

* The limits between the three acknowledged kingdoms of Nature are almoſt impoſſible to be aſcertained; whence ariſes the difficulty of giving any true definition of them: and indeed it may be queſtioned, whether any ſuch definition can take place, when we become ſo far advanced in knowledge, as to ſee clearly the dependence and connexion of all natural bodies into one regular Chain or Syſtem.

However, at preſent, it is neceſſary that the ſeveral parts of Natural Hiſtory ſhould be treated of ſeparately; and as the

whole

These words, *circulation of fluids*, are to be considered as a consequence of what is before supposed, viz. that the mineral bodies are formed *under the surface of our earth*: and by this particular they are distinguished from the subjects of the vegetable kingdom; with which, however, they have some resemblance, some fossils being still produced nearly in the same manner, at least according to our imagination. The clefts, fissures, and countries *, in the rocks, and in the strata of the earth, may be looked upon as answering to the tubes in vegetables, and the water as the fluid common to them both. Fire, of whose nature we still know so little, and which we can hardly determine, whether it belongs to the earth any farther than it exists, and even must exist, within a solar system, may, perhaps, be an auxiliary equally necessary to all the three kingdoms of nature.

On the other hand, we know with a kind of certainty, that if the mineral kingdom is allowed to have existed before the other two, and to have furnished them with materials for their existence, it is at the same time deprived of those wonderful and incomprehensible qualities of life and vegetation, the properties of the animal and vegetable kingdoms.

The descriptions of minerals cannot be extended farther, in a Treatise of Mineralogy, than to

whole extent of this knowledge can hardly be expected from one man, it may perhaps be executed to more advantage by different persons: in the mean time, we must be content with definitions, if they give tolerable ideas of the substances described, though they should not perfectly coincide with the strict rules of logicians. This being premised, I shall endeavour in the Text to give some explanation of my own Essay.

* Countries, an English mine-term for the sides or inclosures of a vein or load of ore, e. g. the country of the load is lime-stone, killas, &c. &c. D. C.

the

the condition in which they are now found will permit; for, with regard to ſuch bodies as are impoſſible to be analyſed or totally decompounded, no account needs to be given of the principia or primary atoms, which have concurred to their formation; ſince it may with confidence be aſſerted, that the Creator made only one kind of matter, from which every thing we meet with in this world has been produced.

Minerals have been defined as bodies that grow by external aggregation of particles; but this definition, on reflection, will hardly be found ſufficient and adequate; becauſe the circles produced by the annual ſtagnation of the ſap in the wood of a tree, and the coats or cruſts of a ſtalactites, are effects nearly reſembling one another. Should it be ſaid that the particles on which the yearly growth of a tree depends, are not carried by the water, and merely depoſited between the bark and the parts of the preceding year now become ſolid, but that they are juices ſecreted from the interior parts thro' the pores of the tree; I could likewiſe ſhow inſtances in the mineral kingdom, that ſeem plainly to indicate ſome proceſs has happened ſimilar to the formation of the callus in a fractured bone; although this happens only at a certain age of the rock: and who knows whether this obſervation or proceſs does not hold good alſo in the animal and vegetable kingdoms? But this ſtill remains too great a problem in regard to the mineral kingdom; and we cannot therefore adopt the expreſs meaning of the "circulation of any juices," ſince we have another refuge left, that is, *ſhrinking* or *contraction*, and *expreſſion* or *ſqueezing*, of which more will be ſaid hereafter. We take more notice perhaps of what happens in the animal and vegetable kingdoms, becauſe we are ourſelves ſubject to the ſame alterations, and we likewiſe outlive the greateſt part of them, therefore we treat them with more eaſe and conveniency; whereas the changes which the mineral kingdom undergoes, are hidden to us, and require many centuries to compleat them.

I cannot ſuppoſe the mineral bodies to be produced by ſeeds, for want of proof; and I do not know why the metals ſhould have any preference in that reſpect. Native or virgin copper and ſilver are produced in the ſame manner as the ſtalactites. The water carries along with it the inviſible particles of lime, copper, or ſilver, and depoſits them upon other ſubjects, either by means of an attractive power in theſe, or by ſome alteration in itſelf, occaſioned by its motion. The precipitated particles are, at the beginning, very eaſily ſeparated; but in proceſs of time they cohere very firmly, as is evidently ſeen in the native precipitated or Ziment-copper *, which, after it has been ſome time taken out of the water, is partly malleable. The figure which native gold and ſilver have in their rocks or beds, does not prove any more than do the metallic iron's or copper's accreting into a moſs-like form in the poor or rich roaſted ores or reguli at the furnaces; it gives us rather an idea, how thoſe accidents happen, merely by the ſhrinking and the ſudden cooling of their ſurfaces: and we can then alſo begin to conceive ſomething of the reaſon why cryſtals are found in a pebble form, or in looſe nodules, as the *petrified melons of Mount Carmel*, and the Italian iron ores, in form of balls, &c. without wanting to have recourſe to the ſuppoſition of a

* Called Ziment-copper from its being firſt noticed in a vitriolic water called ziment, at Herrengrund in Hungary. D. C.

melting

melting heat, if we only carefully obſerve thoſe marks, which, beſides, plainly ſhew their having once been ſoft, or diſſolved.

That mineral bodies are ſtill prepared in that large workſhop of Nature, the *Earth*, in the ſame manner as thoſe which are already full grown ſeem to indicate, is hardly to be poſitively aſſert-ed, ſince we yet want ſufficient obſervations and experiments thereon.

I will, for inſtance, mention the whole Flinty Claſs, of which we have not one obſervation, how they are generated. For if any one pre-tends to have hit upon the quartz cryſtals * in the very inſtant of their ſhooting, it might be aſked, Whether he only depended upon the fi-gure, or if he made ſuch experiments thereon as might convince us, that no calcareous earth, either pure or diſguiſed, was alſo at the ſame time mixed therewith? To enumerate the many different ways of generation, which we have any reaſon to ſuſpect, does not properly belong to this work; beſides, it would carry me too far from my ſubject, and might alſo ſurpaſs my capacity to explain. I will, however, by mentioning the fol-lowing opinions, try to ſpirit up perſons of more experience and leiſure, willing to purſue theſe en-quiries.

Precipitation from or by water, is already menti-oned, as well as a hint given about the formation of flints. This laſt does not ſuppoſe ſuch a ſoft-neſs as that of clay when mollified with water, but a ſlimineſs, a gelatinous, or a mucilaginous matter, and conſequently a more radical ſolution,

* The author uſes the term Quartz criſtals for the true criſtals; for all foreign authors call figured ſpars alſo criſ-tals; and diſtinguiſh them by the name of ſpath or ſpar criſ-tals. D. C.

if I may be allowed that expreſſion; and this is again to be conſidered as a different method.

Another way, and which in our times is much favoured, is that of deſtruction *, partly by very violent means, ſuch as ſubterranean fires, and partly by more mild ones, ſuch as the weathering, waſting, or decompounding away; and by this way we have innumerable varieties, and new compoſitions. The vitriolic and muriatic *acids* do not lie dormant; and being once let looſe by the ſaid way of weathering or deſtruction, they do not ſtop till they are ſaturated with ſomething. Where theſe acids cannot penetrate by themſelves, they are forwarded by the water, which, according to the laws of nature, is almoſt in a conſtant motion: but the effects of theſe ſalts ought again carefully to be diſtinguiſhed from thoſe of the water alone, becauſe this latter acts both as a menſtruum, for inſtance, upon the calcareous earth; and at the ſame time by its *vis inertiæ*, heavineſs and motion, wears off or abrades ſome particles from ſolid bodies, carries them along, and depoſits them in other places, where theſe particles often acquire a different poſition from what they had before. Are the *Bog-ores* produced of decayed mundics, although no vitriolic matter is found in the waters or tracts around them? or, Are they to be reckoned a ſediment of martial earth diſſolved in water alone? Would it be amiſs to ſuppoſe, that a vegetable mould may of itſelf be changed into iron, ſince it is found to yield from a grain to about half of its weight of the ſaid metal, as the experiments

* The original has, "Of deſtruction that acts privative," which I have omitted, as it is quite unintelligible to me. D. C.

demon-

demonſtrate made upon the turf-moors which are at the foot of the hills or high rocks in the provinces of Dalarne, Jemtland, and Herjeadalen, in Sweden? or, that certain vapours have predominated, and ſtill ſhew their power within certain diſtricts, where they attack, and fix themſelves to ſuch matters as are moſt agreeable to them; ſo that trees, which have been buried in the earth, in ſome of its ſubverſions, have met with martial vapours in ſome parts of Bohemia; the flint-producing principle of Loughneagh in Ireland, and at Adrianople; with the inflammable ſubſtance in the ſtrata of the coal-pits in England, and at Boſerup in the province of Skone in Sweden? or, that ſhells muſt, without the deſtruction of their calcareous principles, be changed into a calcareous ſpar, as at the Balſberg in Skone; be filled with flint, as at Vernon in France, and in Siberia; or be penetrated with marcaſite, as at Andrarum in Skone; or with a green copper ore, as at Jarlſberg in Norway? Silver ſeems to predominate at Kongſberg in Norway, as the copper does in the north part of that kingdom: and the ſame kind of ſtone in which gold abounds at one place of the world, may contain none at all at another place; and other ſuch examples occur.

I now leave this important ſubject, that I may not diſcover my farther want of knowledge therein; but I take the liberty, at the ſame time, to give this advice to beginners, *viz.* not to conclude, that one mineral body is produced by another, only becauſe they are ſituated near one another, if it cannot at the ſame time be demonſtrated by the analyſis, or by artificial mutation; nor to content himſelf with making his obſervations only on collections of minerals, or on heaps of ores, but to profecute them to the very workfhop of Nature herfelf, where they may be made with more certainty, though in a narrow compafs; I mean, in the very mines, quarries, and diggings, of the ftrata of the earth. For I myfelf have been aftonifhed to hear that the flint is faid to be produced by a calcareous fubftance, only becaufe it is found in the ftrata of chalk in England, and in the limeftone at Kinnekulle in the province of Weftergottland in Sweden: and I am farther of opinion, that a ftone, feparated from its bed, and thrown loofe on the furface of the earth, does not difcover more marks of increafe, than do bones difperfed in a churchyard.

SECT. II.

The bodies belonging to the mineral kingdom are divided into four different claffes: viz.

1. Earth, or thofe fubftances which are not ductile, are moftly indiffoluble in water or oil, and preferve their conftitution in a ftrong heat *.
2. Inflammables, which can be diffolved in oils, but not in water, and are inflammable.
3. Salts: thefe diffolve in water, and give it a tafte; and when the quantity of water required to keep them in diffolution is evaporated, they concrete again into folid and angular bodies.
4. Metals are the heavieft of all bodies hitherto known; fome of which are malleable,

* The Author, by Earths, does not mean (ftrictly fpeaking) only Earths, but includes all the kinds of ftones or foffils not inflammable, faline, or metallic. D. C.

and

and ſome can be decompounded; nevertheleſs, in a melting heat they can again be recovered, or brought to their former ſtate, by adding to them the phlogiſton they loſt during their decompoſition*.

SECT. III.

The FIRST CLASS.

EARTHS, *Terræ*, are thoſe mineral bodies, not ductile, for the moſt part not diſſoluble in water or oils, and that preſerve their conſtitution in a ſtrong heat.

SECT. IV.

Theſe earths (Sect. III.) are here arranged according to their conſtituent parts, as far as hitherto diſcovered, and are divided into nine orders.

* Here occurs the ſame difficulty in regard to the definitions, as was before (Sect. I.) obſerved, becauſe theſe enumerated claſſes are likewiſe blended one with another; and therefore ſome exceptions muſt be allowed in every one of them: for inſtance, in the firſt claſs, the calcareous earth is in ſome meaſure diſſoluble in water, and pipe clay with ſome others diminiſh ſomewhat in their bulk, when kept for a long time in a calcining heat. In the third claſs, the calx of arſenic has nearly the ſame properties as ſalts; and there is no poſſible definition of ſalt, that can exclude the arſenic, though, at the ſame time, it is impoſſible to arrange it elſewhere than among the ſemi-metals. In the fourth claſs it is to be obſerved, that the metals and ſemi-metals, perfect or imperfect, have not the ſame qualities common to them all; becauſe ſome of them may be calcined, or deprived of their phlogiſton, in the ſame degree of fire, in which others are not in the leaſt changed, unleſs particular artifices or proceſſes are made uſe of: ſome of them alſo may be made malleable, when others are by no means to be rendered ſo. That the convex

The First Order.

The Calcareous Kinds, *Terræ Calcareæ*. These, when pure, and free from heterogeneous matters, have the following qualities common to them all:

1. That they become friable, when burnt in the fire, and afterwards fall into a white powder.
2. That their falling into powder is promoted, if, after being burnt, they are thrown into water, whereby a strong heat arises, and a partial solution.
3. They cannot be melted by themselves, or *per se*, into glass in the strongest fire.
4. When burnt, they augment the causticity of the lixivium of potashes.
5. They are dissolved in acids with effervescence, in the following manner:

   a. The acid of vitriol partly unites with them, and forms a precipitate, which is a gypseous earth, and partly shoots into selenitical crystals with that which is kept dissolved, after a due evaporation.

convex surface metals take after being melted, is a quality not particularly belonging to them, because every thing that is perfectly fluid in the fire, and has no attraction to the vessel in which it is kept, or to any added matter, takes the same figure; as we find the borax, *sal fusibile microcosmicum*, and others do, when melted upon a piece of charcoal: therefore, with regard to all that has been said, it is hardly worth while to invent such definitions as shall include several species at once; we ought rather to be content with perfectly knowing them separately: however, as this is to be an Essay towards forming a System, I have endeavoured, in most parts, to follow the usual rules.

b. With the acid of common ſalt they make a ſal ammoniacum fixum, which alſo partly precipitates itſelf.

c. The acid of nitre diſſolves them perfectly, and does not part with them again, unleſs ſome alcaline ſalt is added.

6. They melt eaſily with borax into a glaſs, which ſuffers impreſſions in a degree of heat below ignition.
7. They likewiſe fuſe into a glaſs with *ſal fuſibile microcoſmicum* with an effervefcence *.
8. They melt the readieſt of all kinds of ſtones, with the calces, into a corroſive glaſs or ſlag.
9. They have alſo ſome power of reducing certain metallic earths or calces; for inſtance, thoſe of lead and of biſmuth, and likewiſe, though in a leſs degree, thoſe of copper and of iron: thus
10. Do they, in this laſt mentioned article (9.), as well as in other circumſtances, reſemble a fixed alcaline ſalt; from whence alſo this whole kind is very often, and properly, called alcaline earths.
11. This whole order of earths is common to all the three kingdoms of nature; becauſe it is found in the bones and ſhells of animals, as well as in the aſhes of burnt vegetables; it muſt, conſequently, have exiſted before any living or vegetable ſubſtance; and is, no doubt, proportionable to its univerſal uſe, diſtributed throughout the whole globe.

* It is to be underſtood, that this effervefcence is alſo made with the borax, as well as with this *ſal fuſibile microcoſmicum*; and it is alſo to be obſerved, that the glaſſes made with theſe ſalts are quite colourleſs and tranſparent.

SECT.

SECT. V.

The Calcareous Earth is found,

I. Pure,

1. In form of powder. *Agaricus Mineralis*, or *Lac Lunæ*.

a. White, is found in moors and at the bottom of lakes, at Reden in the province of Jemtland, at Timmerdala in Westergottland, and also in the provinces of Smoland, Ostergotland, and island of Gottland in Sweden *.

b. Red, is also found in Gottland.

c. Yellow, is found at Timmerdala, in Westergottland †.

* The white mineral agaric, so called from its fineness and lightness, like to the vegetable agaric, is found in such places, i. e. swamp moors or peats in England and Scotland, as likewise in the fissures of the freestone quarries of Oxfordshire, Northamptonshire, &c. but the red and yellow sorts I never heard of in England. See Hist. Foss. nost. p. 82. N°. vii. D. C.

† This kind of earth seems to be an impalpable powder of mouldered limestones abraded and collected by the waters, and is therefore common in the neighbourhoods where limestones are found; and if the stone is at some distance, which is sometimes the case, still nothing contradictory appears in this opinion of the origin of this species; since in that case it has only been carried farther by the greater rapidity of a stronger current of water. When this earth is found in the clefts of rocks, it receives more pompous names; such as *Gur*, *Lac Lunæ*, &c. &c. It burns readily into lime, if it is previously stamped, that it may better cohere: it is then, or in its native state, used for white-washing, but easily rubs off by the least touch. At certain places in the province of Smoland in Sweden, there is found in the moors a white earth, which, by its external appearance, resembles the species here described; but it does not shew any marks of effervescence with acids, nor does it burn into lime. It were to be wished, that those who have an opportunity of getting any quantity of this latter earth, would undertake to examine it better.

SECT. VI.

II. Friable and Compact, *solida friabilis* *. Chalk, *Creta*.

a. White, *Creta alba*, is found in England, France, and in the province of Skone in Sweden, in which last place it is only found adherent to flint. In the two first kingdoms there are large strata of this substance, in which flint is imbedded. This seems to indicate, that the loose flints, or those dispersed on the surface of the earth, have been by some causes carried from their native beds; but, as yet, no one can prove, that chalk and flint are of the same constituent parts.

Chalk is, however, a vague name, also applied to other earths; whence we hear of chalks of various colours: but I do not know of any which are of a calcareous nature, except this only kind here described, and of which there are no other varieties, otherwise than in regard to the looseness of the texture, or the fineness of the particles.

SECT. VII.

III. Indurated, or Hard, *Terra calcarea indurata*. Limestone, *Lapis calcareus*.

A. Solid, of no visible particles, or not granulated, *particulis impalpabilibus*.

This kind varies in regard to hardness and colour, for instance,

a. White, from Hull in England.

* *Solida friabilis* seems contradictory and inexplicable; however, I shall strictly adhere to the Author's definitions, though never so faulty, as I only translate the work. D. C.

b. Whitish

b. Whitish Yellow, is dug at Balsberg in Skone in Sweden, and in the Venetian territories.

c. Flesh-coloured, found in loose masses in the corn-fields in the province of Upland in Sweden.

d. Reddish-brown, found in the island of Oeland, the province of Jemtland, at Rettwick in the province of Dalarne, and at Kimnekulle in the province of Westergottland in Sweden.

e. Grey, at the same places.

f. Variegated with many colours, found in Italy, at Blankenburg, and many other places, and is particularly called Marble *.

* Though it may displease many, yet I must own, I cannot find any characters whereby a marble is to be distinguished from a limestone; and I insist upon it, that nothing but the colours and the texture of the particles distinguish the kinds of limestone. But as Nature has established no rank by colours, and has made every solid limestone equally capable of a polish, before they are spoiled by decaying or decomposing; it is, therefore, out of this species of solid limestone, that such as strike the fancy most, ought to be chosen for ornaments, under the name of Marble.

It belongs to the subterranean geographers to examine, if this solid limestone is ever found otherwise than in strata, and without being mixed with any heterogeneous bodies, that likewise have been changed into a calcareous substance. Here, in the northern parts of the world, it is only found in such a manner as shews it was formed in strata, by water's taking up and carrying its particles, and afterwards depositing them in form of a sediment, just as a slime or mud (which is the finest particles of pounded rocks) gathers together at the stamping mills; and as they are thus formed in the water, there always are heterogeneous parts along with them. These heterogeneous substances are, however, in too small a quantity, to be capable of having changed the whole mass into a calcareous substance (as some pretend); not to mention those circumstances, which, in other respects, make such an opinion very improbable.

g. Black, in the province of Jemtland in Sweden, and in Flanders. See Sect. xxiii. infra.

SECT. VIII.

B. Grained or granulated limestone, *Lapis calcareus particulis granulatis.*

1. Coarse grained and of a loose texture. This is called *Salt-slag* in Swedish, from its resemblance to lumps of salt; and is found in the silver mines at Salberg, in the province of Westmanland in Sweden.

a. Reddish yellow.

b. White. Both these varieties are found in the Salberg mines.

The grained flux spar is also sometimes called *Salt-slag*.

2. Fine grained.

a. White, found at Salberg.

b. Semi-transparent, from Solfatam in Italy, in which native brimstone is found.

3. Very fine grained. This is the common limestone at Salberg.

a. White and green, from the mine at Salberg, called *Storgrufsan.*

b. White and black, from the mine at Salberg, called *Herr Stans Bottn* *.

SECT. IX.

C. Scaly limestone, *Lapis calcareus particulis squamosis sive spatesis.*

* This species has often as beautiful colours as those commonly called marbles; but the texture and coherency of its particles will not admit of a good polish.

1. With

1. With coarse or large scales.

a. White, found at Garpenberg, a copper mine in the province of Dalarne in Sweden.

It is likewise found at Tunaberg, a copper mine in the province of Sodermanland; but with these different qualities, that it loses in a calcining heat forty per cent. of its weight; and, exposed to the air, gets a brownish efflorescence, a sign that it contains some iron, and is a medium between a limestone and the white iron ore called *Stahlsteine*; nor does it excite any effervescence with acids in its crude state.

b. Reddish yellow, from Finland.

2. With small scales.

a. White, from the parish of Tuna in Dalarne, in the marble quarries at Kolmorden in the province of Ostergotland, the parish of Lillkyrke in the province of Nerike, and at Rimito and Pargas in Finland.

3. Fine glittering or sparkling.

a. White, from Carrara in Italy, and Pargas in Finland.

b. Of many colours. This variety makes out a great number of the foreign marbles *.

* This species of limestone takes a good polish, and is therefore used as marble whenever it is found of a fine colour.

It is besides to be remarked, that the grained and scaly limestones (Sect. viii. and ix.) are found either in veins, or form whole mountains, that shew no strata, nor signs of petrifactions.

SECT.

SECT. X.

D. Lime or calcareous ſpars, *Spatum calcareum.*

1. Of a rhomboidal figure.

a. Tranſparent or diaphanous.

1. Refracting ſpar, *Spatum iſlandicum.*

This repreſents the objects, ſeen thro' it, double. It is found at Brattforſs, an iron mine in the province of Wermeland, and alſo in Switzerland and Iceland *.

2. Common ſpar, which ſhews the object ſingle.

1. White, or colourleſs.
2. Yellowiſh and phoſphoreſcent, is found at Jonuſwando in Torneo Lappmark in the Swediſh Lapland.

b. Opaque, *Spatum romboidale opacum.*

1. White, is found in many places, moſtly in clefts, and among cryſtalliſations.
2. Black, from Winorn at Kongſberg in Norway.
3. Browniſh yellow, at Salberg.

2. Foliated or plated ſpar, *Lamelloſum.*

This has no rhomboidal figure, but breaks into thin plates ſo placed as to be not unlike ſheets of thin paper, laid over each other.

a. Opaque white, *Spatum lamelloſum opacum*, from Winorn at Kongſberg, and Scaragrufvan at Egeren in Norway.

* There are vaſt quantities of refracting ſpar (a variety of the Iſlandic) found in the lead mines of Derbyſhire, Wales, and many other parts of England. D. C.

SECT. XI.

E. Cryſtalliſed calcareous ſpars, *Lapis calcareus cryſtalliſatus.* Spar Druſen *.

It is compoſed of the laſt mentioned ſpar (Sect.x.), that has formed itſelf exteriorly into ſeveral planes or ſides, wherefrom many different figures ariſe, the varieties of which have not yet been fully obſerved, nor can they be exactly deſcribed. The following are therefore mentioned, only as inſtances of the moſt regular and common kinds, viz.

1. Tranſparent, *Spatum druſicum diaphanum.*
   - *a.* Hexagonal truncated, *Cryſtalli ſpatoſi hexagoni truncati.* This is found at the Hartz in Germany, and at Jonuſwando in Lapland.
   - *b.* Pyramidal, *Pyramidales.*
     1. Dog's-teeth, *Pyramidales diſtincti.* Found at Salberg, and in the iron mines at Dannemera in the province of Upland.
     2. Balls of cryſtalliſed ſpar, *Pyramidales concreti* †.

        Theſe are balls which have Druſen, pyramidal, octaedral, ſpars accreted in their hollows or centers: they are found at Rettwin in the province of Dalarne, and other places ‡.

* In my Lectures on Foſſils I have adopted this German term of Druſen into our Engliſh language, for a cluſter of regular figured bodies, as a Groupe conveys the idea of a cluſter only, whether regular or of indeterminate figures. D. C.

† The concave figured ſpar balls in the quarries of Somerſetſhire, and other counties in England. Such balls of freeſtone are not unfrequently found. D. C.

‡ The name Spar is very well known, and only uſed to determine a certain figure, viz. when a ſtone breaks into a rhomboidal

SECT. XII.

F. Stalactitical Spar, *Stalactites Calcareus.* Stalactites, Stone Icicle, or Drop-ſtone.

rhomboidal, cubical, or a plated form, with ſmooth and poliſhed ſurfaces, it is called ſpar; and as it is thus applied to ſtones of different kinds, without any regard to their principles, one ought neceſſarily to add ſome term to expreſs the conſtituent parts at the ſame time as the figure is mentioned; for inſtance, Calcareous Spar, Gypſeous Spar, Flux Spar, Shorl or Cockle Spar, &c. This term, however, is not applied but only to earths, and ſuch ores as are of the ſame figure as the Lead Spar, &c.

All cryſtalliſed ſpars, when broken, ſhew the ſparry figure in their particles, and the cryſtalliſation is to be aſcribed to the empty ſpace left by the contraction of the ſparry principle: ſuch holes filled with Druſen of ſpars, are in Swediſh called *Drake*, or *Druſe-hol* †.

The figure of the cryſtals varies more in this genus than in any other, for which no reaſon can be aſſigned; it ought not to be aſcribed to ſalts, as long as the preſence of any ſuch cannot be proved: but there are ſtrong indications to ſuſpect, that other ſubſtances may likewiſe have received the ſame property to aſſume an angular ſurface on certain occaſions. See Mr. Cronſtedt's Introductory Speech at the Royal Academy of Sciences at Stockholm.

Beſides, the conſideration of thoſe figures is a thing of more curioſity than of real uſe, becauſe no miner has yet been able to make any concluſion relative to the quantity or quality of the ores, from the difference of the figures of ſpars found along with them; and the grotto makers never take any notice of the angles or ſides, but think it ſufficient for their purpoſe, if they make a fine or glittering appearance at a diſtance.

It would, nevertheleſs, be well if any one would take upon himſelf the trouble to obſerve, whether each ſpecies of ſpar has not a certain determinate number of figures or ſides, within which it is confined, in its accretions. This has hitherto been impoſſible to do, becauſe all ſpecies of ſpars have been confounded together, without regard to their different principles: though, for my part, I do not think it of any great conſequence.

† What the author ſays in the above note is of little conſequence to the Engliſh ſtudent, as the name of ſpar is never uſed with ſuch latitude in our language. All ſpars of this flakey texture were by our former writers, as Grew and Woodward, called Talcy Spars; but that term now is juſtly exploded. See my Lectures, D. C.

This is formed from water ſaturated with lime, which, while running or dropping, depoſits by degrees the calcareous earth which it has carried along with it from clefts of rocks, or from out of the earth. It is therefore commonly of a ſcaly, though ſometimes of a ſolid and ſparry texture. Its external figure depends on the place where it is formed, or the quantity of the matter contained in the water, and other like circumſtances.

1. Scaled Stalactites of very fine particles, *Stalactites teſtaceus particulis impalpabilibus.*
   a. Of a globular form, *S. teſtaceus globuloſus.*
      1. White, the pea-ſtone from Carlſbad, in Bohemia.
      2. Grey, *Piſoli'hus*, *Oolithus*, from Gottland in Sweden *.

   b. Hollow, in the form of a cone, *Coniformis perforatus.*
      1. White, is found every where in vaults made with mortar, and through which water has had an opportunity to penetrate; and alſo in grottos dug in rocks of limeſtone.

   c. Of an indetermined figure, *Figura incerta. Sinter.*

      From the cavern called the Baumans-hole in the Hartz, the aqueduct at Adrianople, in Italy, and elſewhere.

   d. Of coherent hollow cones, *Conis concretis excavatis.*

* Alſo the Hammites, from its reſemblance to the roes or ſpawn of fiſh. It has been exhibited by Authors as petrified roes. The Ketton free-ſtone, of Rutlandſhire, is a remarkable ſtone of this ſort. D. C.

Of

Of this kind is a ſtalactitical cruſt, which has formed a ſtratum, or rather filled a fiſſure between the ſtrata of the earth at Helſingborg in the province of Skone; it is of a very ſingular figure, reſembling conical caps of paper placed and fixed one in the other, diminiſhing by degrees both in height and the other dimenſions.

2. Solid Stalactites of a ſparry texture, *Stalactites ſolidus particulis ſpatoſis.*

a. Hollow, and in form of a cone, *Coniformis.*

1. White, and ſemitranſparent, from Chaceline near Rouen in France *.

* In making lime-water (*aqua calcis viva*) one may obſerve how the lime gathers, firſt like a pellicle on the ſurface of the water, and afterwards, when this breaks, falls down to the bottom in form of a ſcaly ſediment, which is called *cremor calcis*: after that, a new pellicle is formed, which likewiſe falls down; and in this manner it continues for a long while, although the lime-water had before been paſſed thro' a filtre. This we may alſo imagine to be the way in which the works of Nature are performed: whence the ſtalactites commonly is of a ſcaly texture, or at leaſt diſcovers ſome tendency towards it. But a ſtalactites of a ſparry texture, ſuch as above-mentioned from Rouen, may be ſuppoſed to be owing to a more copious principle concurring at once: and in the ſame manner the ſparry limeſtone and its cryſtalliſations ſeem likewiſe to have been produced, ſince they, as far as I know, are only found in clefts, which, when they have been filled up with a ſtony matter, the Swediſh miners call *Klyfter*, and *Gangar* or *Veins*. In regard to this, the ſtalactites, the ſparry limeſtone, and alſo its cryſtalliſations, might all be ranked under the ſame title in a ſyſtematical deſcription, as very little different from one another, if it was not neceſſary in deſcribing mines, and other works, to give them their ſeparate names: becauſe it is certain, that a piece which is broken from large ſpar-cryſtals, or from ſparry ſtalactites, may in a cabinet paſs extremely well for a common ſparry limeſtone, without leaving any ſuſpicion of its former figure, before it was broke.

SECT. XIII.

B. Satiated or united with the Acid of Vitriol, *Terra calcarea acido vitrioli ſaturata.* Gypſum. Plaſter-ſtone or Parget.

This is

1. Looſer and more friable than a pure calcareous earth.
2. Either crude or burnt, it does not excite any effervefcence with acids, or at moſt it effervefces but in a very ſlight degree, and then only in proportion as it wants ſome of the vitriolic acid to compleat the ſaturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being red-hot, its powder readily concretes with water into a maſs, which ſoon hardens; and then
5. No heat is perceived in the operation.
6. It is nearly as difficult to be melted by itſelf as the limeſtone *, and ſhews moſtly the ſame effects, with other bodies, as the limeſtone: the acid of vitriol ſeems, however, to promote its vitrification.
7. When melted in the fire with borax, it puffs and bubbles very much, and for a long while, during the fuſion, owing to the nature of both the ſalts †.

* I have found moſt of the gypſeous kind, and particularly the fibrous, to melt pretty eaſily by themſelves in the fire.

† When a ſmall quantity of any gypſum is melted together with borax, the glaſs becomes colourleſs and tranſparent; but I have found ſome ſorts of alabaſter and ſparry gypſa that, when melted in ſome quantity with borax, yield a fine yellow tranſparent colour, reſembling that of the beſt topaſes. This phœnomenon might probably happen with every one of the gypſeous kind. But it is to be obſerved, that if too much of ſuch gypſum is uſed in proportion to the borax,

8. Burnt with a phlogiston, it smells of sulphur, and may as well by that means, as by both the alcaline salts, be decompounded; but for this purpose there ought to be five or six times as much weight of salt as of gypsum.
9. Being thus decompounded, the calx or earth which is left, shews commonly some marks of iron.

SECT. XIV.

The Gypseous earth is found

1. Loose and Friable, *Terra Gypsea pulverulenta.* Gypseous Earth, properly so called, *Guhr.*
   a. White, is found in Saxony.

SECT. XV.

2. Indurated, *Terra Gypsea indurata.*
   A. Solid, or of no visible particles, *Solida particulis impalpabilibus.* Alabaster, *Alabastrum.*

   This stone is very easy to saw and cut, and takes a dull polish. It is not always found satiated with the acid of vitriol.

   a. White, alabaster.
      1. Clear and transparent, from Persia.
      2. Opaque, from Italy, and Trapano in Sicily.

   b. Yellow.

borax, the glass becomes opaque, just as it happens with the pure limestone. See the following Treatise on the Pocket Laboratory, Sect. xxviii.

1. Tranſparent, from the Eaſtern countries.
2. Opaque.

SECT. XVI.

B. Gypſum of a ſcaled or granulated ſtructure, *Gypſum particulis micaceis*. This is the common Plaſter-ſtone.

1. With coarſe ſcales.
   a. White, is found in the copper-mines of Ardal in Norway, where this ſtone is the country for the copper-ores.
2. With ſmall ſcales.
   a. Yellowiſh, from Montmartre near Paris.
   b. Greyiſh, from Speremberg in the Mark in Germany.

SECT. XVII.

C. Fibrous Gypſum, or Plaſter-ſtone, improperly (though commonly) called Engliſh Talc by our druggiſts, *Gypſum fibroſum, Alabaſtrites*.

1. With the fibres coarſe.
   a. White, from Livonia.
2. With fine fibres.
   a. White, is found in very thin ſtrata in the alum rock at Andrarum in the province of Skone.

SECT. XVIII.

D. Spar like Gypſum, *Gypſum ſpatoſum*. Selenites. This by ſome is alſo called *Glacies Mariæ*, and is confounded with the clear and tranſparent Mica, *Mica alba pellucida* (Sect. xciv.).

1. Pure

1. Pure Selenites.

A. Tranfparent, *Spatum Gypfeum diaphanum.*

a. Colourlefs, from Swifferland.

b. Yellowifh, from Mont-martre near Paris.

2. Spar like Gypfum, *Marmor metallicum.*

This ftone, on account of its heavinefs, which comes near to that of tin or iron, is fufpected to contain fomething metallic; but, as far as is hitherto known, no one has yet been able to extract any metal from it, unlefs fome traces of iron, which is no more than what all other gypfa contain.

A. Semitranfparent, *Spatum Bononienfe*, the Bononian ftone or phofphorus. Its fpecific gravity is 4,500 : 1000.

B. Opaque.

a. White,

b. Reddifh, are found in Wildeman, at Hartz, and in other German mines.

3. Liverftone, fo called by the Swedes and Germans *. See Sect. xxiv.

* Mr. Margraff has publifhed fome curious experiments in the Memoirs of the Academy at Berlin, about the quality thefe fpars have to yield a phofphorus; and has fhewn, that every gypfeous earth is fit for it, provided metallic particles are not predominant in it: now, as the Bononian fpar, which is ponderous, is of this fpecies, and is the moft fit to be brought to a phofphorus, it is evident, that no metallic mixture is the caufe of its weight. Mr. Scheffer, in the Memoirs of the Academy at Stockholm, for the year 1753, has communicated fome experiments upon a ftone of this kind from China, which prove that it perfectly agrees with the defcriptions given in feveral books, of a ftone called *Petuntfe* by the Chinefe, and which, it is faid, is ufed in their China manufactories. The phofphorus of Baldwin illuftrates Mr. Margraff's experiments. The phofphorefcent quality of thefe ftones is, however, different from that of the fparry limeftones

SECT. XIX.

E. Cryſtalliſed Gypſum, *Gypſum cryſtalliſatum*. Gypſeous Druſen, *Druſeæ Gypſeæ*.

1. Druſen of cryſtals of pure ſparry gypſum.

A. Wedge-formed, *Cuneiformes*, are compoſed of a pure ſpar-like gypſum. See Sect. xviii. 1.

1. Clear and colourleſs, from Switzerland.
2. Whitiſh yellow, from Montmartre.

B. Capillary, *Capillares*.

a. Opaque, whitiſh yellow, from Stollberget in Kopparberg Slan in Sweden.

C. Of ponderous ſpar-like Gypſum, *Marmor metallicum Druſicum*.

1. Jagged or like cock's combs, *Criſtati*. Theſe reſemble cock's combs, and are found in clefts or fiſſures accreted on the ſurfaces of balls of the ſame ſubſtance.
2. White, from Hartz and Kongſberg in Norway.
3. Reddiſh, from Wildeman mine in the Hartz.

SECT. XX.

F. Stalactitical Gypſum, *Stalactites Gypſeus*. *Gips Sinter*.

This, perhaps, may be found of as many different figures as the calcareous ſtalactites or ſinters. See Sect. xii. *c*.

I have only ſeen the following, viz.

limeſtones and fluors, which is only produced by their being ſlowly heated, and ſeems to ariſe from a phlogiſton, which is deſtroyed in a glowing heat.

1. Of

1. Of no viſible particles, *particulis impalpabilibus*, in French *Grignard.*
   A. Of an irregular figure.
      a. Yellow, from the plaſter-pits at Montmartre near Paris.
      b. White, from Italy.

   This is uſed in ſeveral works, as alabaſter, eſpecially when it is found in large pieces; and then it commonly varies in colour between white and yellow, as alſo in tranſparency and opacity.

2. Of a ſpar-like texture, *Textura ſpatoſa.*
   A. In form of a cone.
      a. White and yellow, from Trapano in Sicily.
   B. Of an irregular figure.
      a. White, from Stollberget in Kopparberg Slan in Sweden *.

SECT. XXI.

C. Calcareous Earth ſatiated with the acid of common ſalt, *Terra calcarea acido ſalis com-*

* What has been before obſerved (Sect. xi. xii.) about accreted ſpars and ſinter, may alſo be applied to this ſpecies †.

† Gypſeous foſſils abound in England. Plaſter-ſtone, granulated and ſolid, ſome ſo very fine as to be alabaſter, that is, take a ſurface and politure, are plenty in Derbyſhire and Nottinghamſhire, where are large pits of it, and alſo in moſt of the cliffs of the Severn, eſpecially at the Old Paſſage in Somerſetſhire. A very fine ſemipellucid ſolid alabaſter is found in Derbyſhire. Fibrous talcs, very fine, are found in the ſame pits of plaſter-ſtone above-mentioned, and many other places. Selenites of many kinds abound in England in clays, inſomuch that it is needleſs to enumerate the places. Very fine gypſeous Druſen are found in Sheppy-iſle, and the moſt beautiful I have ever ſeen, perfectly pellucid as criſtal and large, has been dug from the ſalt-rocks at Nantwich in Cheſhire. The Selenites Rhomboidalis, a rare foſſil in other countries, is frequently found in England; but Shotover-hill in Oxfordſhire, is famous for them. I do not know of many of the ſpar-like gypſa of Engliſh product, but the Iſle of Sheppy affords a kind (to my knowledge peculiar

munis ſaturata. *Sal Ammoniacum fixum naturale.*

This is found,

1. In ſea water.
2. In ſalt pits.

It is formed in great quantities at the bottom of the ſalt-pans of the ſalt works. It attracts the moiſture of the air *.

SECT. XXII.

D. Calcareous Earth united with the inflammable ſubſtance, *Terra calcarea phlogiſto mixta, ſeu impregnata.*

These have a very offenſive ſmell, at leaſt when they are rubbed, and receive their colour from the phlogiſton, being dark or black in proportion as it predominates.

SECT. XXIII.

1. Calcareous Earth mixed with phlogiſton alone, *Terra calcarea phlogiſto ſimplici mixta. Lapis ſuillus,* Foetid ſtone and ſpar, or ſwine ſtone and ſpar. Perhaps the ſmell

* Perhaps ſome kinds of limeſtones may exiſt that contain more or leſs of the acid of common ſalt, though they are not yet diſcovered. It is almoſt incredible what quantity of ſuch diſſolved calcareous earth is contained in ſea-water; and from which the teſtaceous animals or ſhells get the materials for their ſhells or coverings. Perhaps Nature has a particular and ſecret method of producing a mineral alcali out of the calcareous earth, and has thus laid this earth, as well as the acid of common ſalt, together in the water, in order to combine them by degrees, and produce the common ſalt.

culiar and particular to that ſmall ſpot of ground, and not found any where elſe in the world) fibrous, and always accreting in radiations like a ſtar on the Septaria, thence called Stella Septarii. D. C.

of

of this ſtone may not be ſo diſagreeable to every one: it goes ſoon off in the fire. Its varieties, in regard to the texture, are as follow:

A. Solid, or of no viſible or diſtinct particles, *Solidus particulis impalpabilibus.*
  a. Black: the marble dug in Flanders, and in the province of Jemtland in Sweden.

B. Grained, *Particulis granulatis.*
  a. Blackiſh brown, from Wretſtorp at Skoers in the province of Nerike.

C. Scaly, *Particulis micaceis.*
  1. With coarſe ſcales.
    a. Black, at Nas in Jemtland.
  2. With fine glittering or ſparkling ſcales.
    a. Brown, from Kinnekulle in the province of Weſtergottland, and Rettwick in the province of Dalarne.

D. Sparry.
  a. Black,
  b. Light brown,
  c. Whitiſh yellow, found in the ſlate rocks in the province of Weſtergottland.

E. Cryſtalliſed.
  1. In a globular form, dug up at Kraſnaſelo in Ingermanland *.

SECT. XXIV.

1. Calcareous Earth united with phlogiſton and the vitriolic acid, *Terra calcarea phlogiſto*

* Many of the limeſtones of England are of this ſection, being extremely fœtid when violently ſtruck. In regard to the fœtid ſpars, I have had them from the lead mines of Flintſhire in Wales. D. C.

et

et acido vitrioli mixta. Leberſtein of the Germans and Swedes. *Lapis hepaticus.*

This ſtone ſometimes readily, at other times only when rubbed, ſmells like the *hepar ſulphuris*, or gun-powder. It excites no efferveſcence with acids, and is a medium between the *gypſum* and the fœtid ſtones of the laſt ſection, to which it has, however, generally been claſſed, although no lime can be made from it; whereas they are the fitteſt of all the different limeſtones to be burnt into lime. It is found

A. Scaly.

1. With coarſe ſcales.
   a. Whitiſh yellow, from Stollen at the mine called Gotteſhulffe in der Noth at Kongſberg in Norway.
2. With fine glittering or ſparkling ſcales.
   a. Black, is found in form of kernels or balls in the alum-ſlate at Andrarum in the province of Skone *.

* The method that Nature takes in combining thoſe matters which compoſe the liver-ſtone, may, perhaps, be the ſame, as when a lime-ſtone is laid in a heap of mundic, while it is roaſting: becauſe there the ſulphur unites itſelf with the lime-ſtone, whereby the limeſtone acquires that ſmell common to liver of ſulphur, inſtead of which the vitriolic acid alone enters into the formation of gypſum. How the ſulphur combines itſelf may likewiſe be obſerved in the ſlate-balls or kernels from Andrarum alum mines, where it ſometimes combines itſelf with a martial earth, of which this ſlate abounds, and forms therewith pyrites within the very ſlate-balls. I have called this ſpecies the Liver-ſtone, notwithſtanding that name, by reaſon of its colour, has before perhaps been given to ſome other kind; but as (in my opinion) the colour is a circumſtance of very little or no importance in mineralogy, ſo as not to deſerve to be taken notice of, in preference to other characters of more conſequence, I hope my boldneſs herein will be excuſed. The fœtid or ſwine-ſtones, and the liver-ſtone, are, in regard to the ſtructure

of

SECT. XXV.

E. Calcareous Earths blended with an argillaceous earth, *Terra calcarea argilla intimè mixta.* Marle, *Marga.*

1. When crude, it makes an effervefcence with acids, but
2. Not after having been burnt; by which operation it is obferved to harden, in proportion as the clay exceeds the calcareous fubftance.
3. It eafily melts by itfelf into a glafs, and even when it is mixed with the moft refractory clay.
4. It is of great ufe in promoting the growth of vegetables, fince the clay tempers the drying quality of the calcareous earth.
5. When burnt in a calcining heat, it readily attracts water: and, expofed to the air, in time, it falls into a powder.

The varieties of this kind, worthy to be taken notice of, depend on the different quantities of each of their component parts, and on the quality of the clay. I fhall, for inftance, fpecify the following examples.

SECT. XXVI.

1. Loofe and compact, *Marga friabilis.*

This diffolves in water like common clay.

of their parts, fubject to the fame varieties as the other fpecies of lime-ftone: and it is to be obferved, that a volatile alcali is commonly fuppofed to have entered into the compofition of the fœtid ftones, though it has never yet been difcovered by any experiment.

a. Reddifh

a, Reddiſh brown; dug up in the iſland of Gottland in Sweden.

b. Pale red; dug up at Upſal in Sweden. This, when burnt, is of a yellowiſh colour, and uſed for making the earthen-ware in the potteries at Rorſtrand near Stockholm.

SECT. XXVII.

2. Semi-indurated, *Marga indurata aëre fateſcens.*

It is nearly as hard as a ſtone when firſt dug up, but moulders in the open air. It is moſtly ſlatty, and is not uncommon in the ſlate rocks of Sweden, where it lies between the thick beds of ſlatty limeſtone, and is is alſo found by itſelf, forming very thick ſtrata. It does not diſſolve in water, till, by a conſiderable length of time, it has mouldered to a powder.

a. Grey.

b. Red.

These are found at Styggforſſen, in the pariſh of Rettwick, in the province of Dalarne.

SECT. XXVIII.

3. Indurated or ſtone marle, *Marga indurata.*

A. In looſe pieces, *Marga indurata amorpha*; by the Germans called *Duckſtein*, or *Tophſtein.*

a. White, from Woxna in Carelen, and in the river at Nykioping in the province of Sodermanland.

b. Grey, found in the provinces of Angermanland and Skone.

It

It is formed from a ſediment which the water carries along with it.

B. In continued ſtrata, *Marga indurata ſtratis continuis.* Hard ſlatty marle.

SECT, XXIX.

F. Calcareous Earth united with a metallic calx, *Terra calcarea metallis intimè mixta.*

Here, as well as in the others, ſuch a mixture or combination is to be underſtood, as cannot be diſcovered by the eye alone, without the help of ſome other means.

The ſubjects belonging to this diviſion loſe the property of raiſing an effervefcence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found ſome that contained twenty or thirty per cent. of metal, and yet have ſhewn their calcareous nature by the nitrous acid.

There are no more than three metals hitherto known to be united in this manner with the calcareous earth, viz.

SECT. XXX.

1. Calcareous Earth united with Iron, *Terra calcarea marte intimè mixta.* White ſpar-like Iron Ore, *Minera ferri alba.* The *Stahlſtein* or *Weiſes Eiſenerz* of the Germans.

1. This ore, however, is not always white, but commonly gives a white powder when rubbed.

2. It becomes black in the open air, as likewiſe in a calcining heat.

3. In this laſt circumſtance it loſes thirty or forty per cent. of its weight, which by diſtillation has been found owing to the water that evaporates; and it is poſſible that ſome ſmall quantity of vitriolic acid may, at the ſame time, evaporate with the water.

4. It is of all the iron ores the moſt eaſy to melt, and is very corroſive when melted.

This kind is found,

SECT. XXXI.

A. Looſe, *Minera ferri alba pulverulenta*, and is the mouldered part of the indurated ſort.

a. Black.

Is like ſoot. It is found at Weſter-ſilverberget in Kopparberg Slan in Sweden among the earth that covers the white iron ore.

b. Dark brown.

This ſomewhat reſembles umbre, and is found to this day at Solſkienſberget in Norberg in the province of Weſtmanland.

SECT. XXXII.

B. Indurated, *Indurata.*

1. Solid, of no diſtinct particles, *Solida particulis impalpabilibus.*

a. Red, *Minera ferri calcarea rubra.*

Looks like red ochre, or the red hæmatites, but diſſolves in the acid of nitre with a great efferveſcence. It is found at Hellefors in the province of Weſt-

Weſtmanland, and at Graſberg in Grangierde in the province of Dalarne.

SECT. XXXIII.

2. Scaly, *Particulis micaceis.*
   - *a.* White, from Naſſau Siegen, and Weſter-ſilverberget in the province of Weſtmanland.
   - *b.* Blackiſh grey, in Smalkalden, and the Old-mines at Helleforſſen in Weſtmanland *.

3. Spar-like, *Spatoſa.*
   - *a.* Light brown, from Naſſau Siegen, and Smalkalden.

4. Druſen, *Druſica.*
   - *a.* Blackiſh brown, from Smalkalden.
   - *b.* White.
     1. Porous. This is often called *Eiſenblute*, or *flos ferri.* It is found at Weſter-ſilverberget.
     2. Cellular, from Weſter-ſilverberget ‡.

SECT. XXXIV.

2. Calcareous Earth united with Copper, *Terra calcarea croco ſeu calce Veneris intrinſecè mixta.*

* In England in the Foreſt of Dean, where it is called Grey Ore, and at Bigrig Moor in Cumberland.

‡ Theſe kinds, in regard to their texture, are ſo like thoſe calcareous ſtones we call Limeſtones (Sect. ix.) and Spars (Sect. x. xi.), that they may be eaſily confounded with one another, were not the other characters obſerved at the ſame time.

A. Looſe and friable, *Pulverulenta ſive friabilis.* Mountain blue, *Cæruleum montanum.* Germanicè, *Bergblau.*

This diſſolves in aquafortis with effervescence.

SECT. XXXV.

B. Indurated, *indurata.*

1. Pure calcareous earth mixed with calx of copper. Armenian ſtone, *Lapis Armenus.*

Such, according to the deſcription of authors, ought the nature of the ſtone called Lapis Armenus to be, though the druggiſts ſubſtitute in its ſtead a pale blue Lapis Lazuli, free from Marcaſite.

SECT. XXXVI.

2. Gypſeous Earth united with calx of Copper, *Terra gypſea Venere mixta.* Is of a green colour, and might perhaps be called Turquoiſe ore, or *Malachites*; though I do not know if all ſorts of Turquoiſe ore are of this nature.

a. Semi-tranſparent, is found at Ardal in Norway *.

* By chemiſtry we know, that alcaline ſalts produce a blue colour with copper, which is changed into green, as ſoon as any acid is added; and from thence the reaſon is obvious, why a green colour may be found among calcareous copper ores, viz. when the vitriolic acid is in the neighbourhood of it.

SECT. XXXVII.

3. Calcareous Earth united with the Calx of Lead, *Terra calcarea cerussa nativa intimè mixta.*

This is a lead ochre, or a ſpar-like lead ore, which, in its formation, has been mixed with a calcareous earth, and for that reaſon effervefces with acids.

A. Looſe and friable, *Friabilis.*

a. White, from Kriſterſberget at Nya Kopparberget in Weſtmanland.

SECT. XXXVIII.

B. Indurated.

1. Scaly.

a. Yellowiſh, from Kriſterſberget †.

SECT. XXXIX.

Obſervations on the Calcareous Earth in general.

The calcareous earth is diſtributed over the whole world in proportion to the great uſe made of it, though it ſometimes is abſorbed and concealed in heterogeneous ſubſtances. If it could be proved, that Nature, to perform its works, does not require more than thoſe two active

† Both theſe varieties contain a conſiderable quantity of lead, viz. forty per cent. more or leſs, and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore (Sect. xxxiii.). Thus may theſe be diſtinguiſhed from other lead-ochres and ſpar-like lead ores, which are much richer in lead, and never efferveſce with acids. Theſe laſt mentioned alſo ſeem to be produced by nature, nearly as the ſpar-like lead ores, and as the *flores Saturni* are formed in calcining a regule of lead.

 agents,

agents, the acid and the alcali, and that the calcareous earth might, under certain circumſtances, be changed into a mineral alcali, as ſome have conjectured; the neceſſity of the exiſtence of the calcareous earth is ſufficiently obvious. But all theſe hypotheſes I paſs over, ſince they for a long while have been, and will, perhaps, remain for ever undecided; it being of more conſequence to take notice of the advantages which are to be derived from it in human œconomy, ſince it is more or leſs employed in moſt trades. However, I do not intend to enter into all thoſe particulars, but only to mention how the calcareous earth, when in its crude ſtate, is commonly made uſe of.

When in the form of a looſe earth, (Sect. v. 1.) it is uſed for white-waſhing; and is mixed with clay in agriculture: for, according to Dr. Kullbell's rules of vegetation, its alcaline quality ſerves to unite fat ſubſtances with water: beſides that it is of a drying nature, and renders the clay leſs coherent, or, as the farmers ſay, "makes the plowing eaſier." Hence this looſe earth, in ſome foreign countries, is called marle; for, when added to clay, it promotes the production of marle. The *humus conchacea*, or ſhell or ſea-ſand, is looked upon as pretty nearly of the ſame quality; but it is unfortunate that clay for the moſt part is ſcarce in thoſe places, where the calcareous earth is found in plenty, and that ſometimes more is expected from this laſt than it poſſibly can perform. Looſe earth may eaſily be made into lime, if it is previouſly ſlacked with water, and made up in moulds.

The indurated calcareous earth or ſtones, in maſſes or lumps, are very uſeful in arable land, becauſe it moulders by degrees on the ſurface, and attracting the water, retains it longer than

moſt

moſt other kinds of ſtones. The arable lands in the province of Jemtland, at Rettwick in Dalarne, at Kinnekulle in Weſtergottland, and in other places, which conſiſt merely of a calcareous earth, or a mouldered ſlate, would ſuffer a great deal from the ſun, and a dry ſeaſon, if they were not covered with lumps of limeſtone.

The art of building cannot be purſued without the uſe of limeſtone; and in this buſineſs alone it is known, and made uſe of under different names.

The ſolid limeſtone (Sect. vii.) commonly found in Sweden, is moſtly ſlatty, and when it is of ſuch indifferent colours as not to deſerve poliſhing, is called in Swediſh *Telgſtén*, *Alfvarſten*, and *Oelandſten*, in Engliſh ſimply Limeſtones. The thickeſt ſtrata are always employed in large works, to which purpoſe they are very well adapted; and the thinner are cut into ſquare ſlabs to pave the floors, and for the ſtairs of houſes, and are alſo applied to other uſes. But great care muſt be taken in the choice of theſe ſtones, ſince it will happen that the finer works, made of this kind of ſtone, may, in length of time, crack and break into two or more plates, eſpecially if they are expoſed to the open air, becauſe this ſtone is for the moſt part ſet with ſmall partition veins of indurated marle, which moulders in the air. And this is the reaſon why the uppermoſt ſtrata, in thoſe quarries, are always rejected, and regarded as a different kind ofſtone, and are, by the Swediſh workmen particularly, called *Gorſten*, in Engliſh Rubble-ſtone.

When the limeſtone is of brighter colours, though ſometimes no more than only of a dark brown, it receives the pompous name of Marble: and for ſuch works as are to be poliſhed, the pieces are always choſen out of the thick and ſolid ſtrata, which lye ſo deep under-ground, that they have not been ſpoiled by weathering or decaying. This ſtone is likewiſe the moſt proper for that purpoſe, in preference to all other limeſtone, becauſe it is perfectly opaque, and reflects the light from the ſurface. Moſt of the Italian and antique marbles are of this kind, for inſtance:

Marmore Nero di Fiandra, —	The black marble of Flanders.
——— *Giallo Antico*, ——— —	Yellow, with ſome white veins.
——— *di Fiume d' Arno*, ———	Yellow, with black dendrites.
——— *di Fiorenza, Paeſino*,	Yellow, with brown figures, reſembling ruins.
——— *di Porto Venere*, ———	Black, with yellow veins.
——— *Nero et Bianco di Carrara*, ——— —	Black and white.
——— *Tartufato d'Urbino*,	Pale yellow, with ſpots of a blackiſh grey colour.
——— *Brocatella di Spagna*,	Yellow white and red.
——— *Palombina antica*, --	Pale yellow.
——— *Alberino di monte Gallicano*, ———	Olive colour, with deeper coloured croſs-lines and dendrites.
——— *Roſſo di ſan guiſto*, ———	Browniſh red.
——— *Carnagione di Piſtoia*,	Fleſh-coloured and yellow.
——— *Fior di Perſico di Saravezza*, ———	Crimſon, white and grey.
——— *Pavonazzo*, ———	Reddiſh-brown lumps on a whitiſh ground.
——— *Bardiglio*, ———	Bluiſh-grey.

With infinite more varieties, whoſe number is improperly augmented by thoſe who for intereſt-ſake collect ſpecimens, and likewiſe by ſome virtuoſos, who pay too much regard to colours and figures. From the above we find, that the Italian names are for the moſt part taken from the colours. When they have a marble from an unknown place, they call it *antico*. Every one that has a number of bright colours, is called *brocatello*,

brocatello, or *brocettelato*. The figures are chiefly regarded in the *Paesino di Fiorenza*, *Alberino di Monte Gallicano*, &c. &c. When ſome of the originals are wanted to compleat the whole ſet of marbles, they are ſubſtituted either by others, that have the moſt reſemblance to them, or by white marbles ſtained or coloured; and this is the caſe with the *Marmore di ſangue di Dragone*.

To this ſpecies of ſolid limeſtone alſo belongs the marble from Blankenburg, which is red, black, and white; likewiſe that from the province of Jemtland in Sweden, which is black and white, or only black, and the French marbles, viz. *Serfontaine*, *Antin*, *Seracolin*, *St. Baume*, *Servelat*, &c. &c. which have ſeveral bright colours.

The fineſt ſolid modern marbles are thoſe from Italy, Blankenburg, France, and Flanders. There are alſo marbles dug in Saxony, and other parts of Germany, in Norway, and Sweden; but either they are not of ſuch agreeable or ſtriking colours, or elſe are of that ſpecies which is called the Scaly glittering Limeſtone, mentioned Sect. ix.

There are, however, ſeveral among the abovementioned marbles, which are partly mixed with the ſcaly limeſtone (Sect. ix.), though not in ſuch a quantity as to conſtitute the principal part of the ſtone, but only as a ſubſtance which has joined together lumps of the ſolid limeſtone, or elſe filled up its empty crevices or cracks. This kind, however, ought not to be rejected, but might be uſed as a marble, if only ſuch pieces were choſen that have the fineſt texture: becauſe thoſe with coarſe ſcales, when poliſhed, are of an icy appearance, as maſons term it, and do not ſhew their true colours, by reaſon of the ſemi-tranſparency of their particles, and their different poſitions in regard to one another, which may be ſeen in the marble from the pariſh of Perno in Finland.

Of the fine glittering limeſtone (Sect. ix.), are the following:

Marmore Bianco di Carrara, the white marble, the *Saligno*, the *Parian*, the white Italian marble; which, however, is never poliſhed when made uſe of, but only finely ground down; the *Bigio antico*, *Porta Santa*, *Carnagione di Verona*, *et di Siena*, *Tigrato antico*, *Roſſo antico*, *Giallo antico in oro*, *fiorito*, *et Giallo abruſciato*; every one of which is ſomewhat tranſparent at the edges.

In the pariſh of Pargas near Abo in Finland is found a white marble, which, to judge from the ſamples I have ſeen, gives room to hope that it is as good as the Italian, when they have got beneath the firſt ſtratum. But the other Swediſh white limeſtones, for inſtance, that from Lillkyrke and other places, are either of too coarſe a texture, or ſo intermixed with ſemi-tranſparent particles, as to give them, at a diſtance, a very diſagreeable appearance, as if they were dirty.

The antient ſtatuary marble is likewiſe very tranſparent: but as this tranſparency is equally diffuſed through all parts of the ſtone, it does no harm, but makes it rather look like alabaſter.

While we are on the ſubject of marbles, it is neceſſary to obſerve, that as the Italians have a well founded right of giving names to the different varieties of marbles, and of furniſhing us with ſamples, both of ſuch as are found in their country, and of foreign ones which in former ages have been employed there, and now are called *Antichi*; it is in regard to thoſe collections, or *Studie*, that moſt ſtones which take a poliſh, have

have been called Marble, although the Italian maſon himſelf knows extremely well how to diſtinguiſh a Marble, a Jaſper, and a Granite, from one another, giving the two laſt names only to marbles of ſuch colours as thoſe ſpecies generally have, when he either cannot get any real ones of thoſe harder ſtones, or will not give himſelf the trouble to poliſh them. This confuſion in the names may, however, in regard to this ſyſtem be tolerated, ſince theſe three different ſpecies of ſtones, viz. the limeſtones, the jaſpers, and the granites, are here ſeparately deſcribed: but ſince they cannot all be worked in a like manner, nor do they equally reſiſt the violence of time, they deſerve to be known by the architects in a clearer manner, and by ſeparate names.

A yet leſs confuſion is that of the Saxum, which, tho' compounded of limeſtone and ſerpentine *, is called Marble, not only when it contains a greater quantity of the limeſtone, as the marble from Kolmorden in the province of Oſtrogottland, but alſo when the ſerpentine predominates, as in the marble called *Pozzevera de Genoua*, and alſo a kind of green marble from Spain, becauſe this kind of ſtone is as eaſy to cut and work as a true marble, although the ſerpentine is ſomewhat ſofter, and eaſier to poliſh.

The calcareous ſpar (Sect. x.), and its cryſtalliſations (Sect. xi.), are more difficult to be burnt into lime, than other limeſtones; they are therefore of no great uſe in architecture, any further than that they may be employed in making grottos: Nature has alſo made the quantity of this kind proportionable to its uſe.

* What our Author calls Serpentine, is a ſpecies of nephritic, and of the claſs of Talcs. D. C.

But

But the gypſum or plaſter ſtone, on the contrary, is of very great conſequence in building; and its ſtrata, which are very ſparingly diſtributed in the earth, are worth ſearching for. If it is true, that the ſtrata of the earth are ſituated in a regular order throughout the whole globe, as ſome aſſert, and concerning which they have formed ſyſtems to themſelves, founded upon obſervations made only at ſome few places, we might expect to have a conſiderable quantity of this ſtone; but there are innumerable experiments yet wanted, before this can be demonſtrated. In the mean while, it may be aſked, and with ſome reaſon, If the gypſum is to be ſearched for in any other places beſides thoſe ſtrata where there is a poſitive proof of their being formed in the middle age, by means of water carrying their particles with it, and depoſiting them as a ſediment there, and where alſo the vitriolic acid has been preſent? Likewiſe, If theſe ſtrata ought before to have been ſet on fire, whereby the vitriolic acid has been ſeparated from the inflammable ſubſtance, and afterwards fixed itſelf to a pure calcareous earth ‡?

The miners uſe crude limeſtone to make the *hearths* of their iron furnaces, and as fluxes in melting their ores. The ſolid and the ſcaly limeſtones are both employed to the former uſe; but the ſcaly (Sect. ix.) is the beſt, and next to that the grained limeſtone (Sect. viii.).

Thoſe who intend to ſearch for limeſtone to make lime, and are afraid to miſtake the white iron ore (Sect. xxx.) for it, ought only to obſerve, that the latter always decays in the open air into

‡ This whole paragraph, eſpecially the latter lines, is very obſcure and unintelligible. D. C.

a black

a black or blackiſh brown powder, and becomes alſo of the ſame colour in the fire. However, when this iron ore contains only a very ſmall quantity of iron, it may be uſed to make lime; though it becomes of a grey colour, juſt as when clay is mixed with limeſtone, as is the Alfwarſten, in which there is always ſome mixture.

It ſeems as if the white iron ore might be uſed with advantage, and preferably to others, in making cement, whoſe conſtituent parts are always lime and iron; but neither is it apt to concrete, when once mouldered; nor by experiments made for that purpoſe, has it diſcovered any quality of binding or uniting: we muſt, therefore, examine other ſubſtances, which may better anſwer the intention; and then it will be found, that iron, which is too much in its metallic ſtate, is eaſily affected by the vitriolic acid, whereby the cement made of it would in length of time be diſſolved, and rendered uſeleſs; nor, on the contrary, is a perfectly calcined iron of ſo much ſervice, as when it has ſome of its phlogiſton left. For inſtance, a cement prepared from the ſlags of a ſmith's forge, mixed with lime and coarſe ſand, has been found, in ſome reſpect, to anſwer all the good effects expected, it depending only on time to ſhew, if it is durable enough. The *Terra Puzzolana* and *Terras* are nothing elſe than iron ores mixed with a yet unknown earth. Its effect, however, in the cement, may, perhaps, depend only on the iron, which has been reduced into a particular ſubſtance by means of ſubterraneous fires, for their native places retain evident ſigns thereof.

If the ſlate in Henneberg, or Kinnekulle in the province of Weſtergottland, ſhould happen

happen to catch fire, the uppermoſt ſtratum, which now conſiſts of a mixture of iron and different kinds of rocks called *Graberg*, in the accounts given of them, they might, perhaps, be changed, partly into ſlag, and partly into *Terra Puzzolana*.

SECT. XL.

The Second Order.

The Siliceous Kind, *Siliceæ*.

This ſiliceous earth is, of all others, the moſt difficult to deſcribe and to diſtinguiſh perfectly: however, it may be known by the following characters, which are common to all bodies belonging to this order.

1. In its indurated ſtate it is hard, if not in regard to the whole, yet at leaſt in regard to each particle of it, in a degree ſufficient to ſtrike fire with ſteel, and to ſcratch it, when rubbed againſt it, though the ſteel be ever ſo well tempered.
2. When pure, and free from heterogeneous particles, it does not melt by itſelf, neither in a reverberatory, nor in a blaſt furnace.
3. After being burnt, it does not fall to a powder, neither in the open air, nor in water, as the calcareous order does, but becomes only a little looſer and more cracked by the fire, unleſs it has been very ſlowly, and by degrees, heated.
4. It excites no effervеſcence with acids.
5. In the fire it melts eaſieſt of all to a glaſs with the fixt alcaline ſalt; and hence it has got the name of Vitreſcent, though this name is, properly ſpeaking, leſs applicable

to

to this order, than to a great many other earths ‡.

SECT. XLI.

The mineral bodies that are comprehended in this order, are, indeed, ſomewhat different from one another. This difference, however, on firſt ſight may be diſcerned; but, in regard to their effects in the fire, and other chemical experiments, it cannot be eſteemed of any great conſequence, at leaſt while we are no farther advanced in the art of decompounding theſe hard bodies, and as long as no one has thought it worth the trouble and expence to uſe thoſe means which are already diſcovered for this purpoſe; I mean the burning-glaſs or concave mirror; and to continue ſuch experiments which Mr.

‡ It is not yet known, if there is any looſe earth of this kind to be found, or if the indurated one is produced of a clay, either pure, or mixed with the calcareous earth, which afterwards has been diſſolved, in order to produce this; becauſe I have not yet, at leaſt for my own part, found any looſe earth that I can ſuſpect to be a ſiliceous one, except that which remains after ſtones of this kind are decayed, and which is found in form of a white cruſt on the ſurface of thoſe ſtones that lye to the day, or on the earth. This being afterwards worn off, and carried away by the water, is, perhaps, gathered together in form of ſtrata. In the ſame manner window-glaſs likewiſe moulders in length of time: but it cannot, therefore, be ſuppoſed, that any ſuch decayed particles may, without being previouſly diſſolved in ſome new menſtruum, be reduced into their former ſubſtance. I am rather inclined to believe, that Tripoli is ſuch a mouldered ſiliceous earth, and that the method of Nature in producing moſt of the flinty kind, is ſuch as we do not rightly know, nor have patience to follow, yet imagine that we in ſome meaſure imitate it in making of glaſs, ſince both theſe have ſome effects common with one another.

Pott has ingeniously begun, as a basis for his *Lithogeognosia*. For want of this, there is no other way left, than to consider these bodies as simple substances (how much soever compounded they may be), in the following manner.

SECT. XLII.

A. Diamond, *Adamas gemma*,
Which,
1. Of all stones, is the hardest.
2. Is commonly clear, or transparent; which quality, however, may, perhaps, only belong to its crystals, but not to the rock itself from which they have their origin.
3. Its specific gravity is nearest 3,500. When brought to Europe in its rough state, it is in form either of round pebbles, with shining surfaces, or of crystals of an octoedral form *.
   a. Colourless, or diaphanous, or the diamond properly so called.
   But it also retains this name when it is tinged somewhat red or yellow. Being rubbed, it discovers some electrical qualities, and attracts the mastic.

* The diamonds commonly crystallize into octoëdral forms, which, however, often are found somewhat irregular, especially when the surface inclines to crystallize, during the shooting of the whole crystal, and also when several of them unite together into a groupe; in which latter circumstance the one hinders the other from assuming its regular form; and of this I have seen several instances. But the octoëdral is not the only regular form which the diamond assumes; I have lately seen a rough diamond, or in its native state, in a regular cube, with its angles truncated or cut off. E.

SECT.

SECT. XLIII.

B. Red, Ruby, *Adamas ruber.* *Rubinus.*

Which, by lapidaries and jewellers, is, in regard to the colour, divided into,

1. The Ruby, of a deep red colour, inclining a little to purple.
2. Spinell, of a dark colour.
3. The Balaſs, pale red, inclining to violet.

This is ſuppoſed to be the mother of the rubies.

4. The Rubicell, reddiſh yellow.

However, all authors do not agree in the characters of theſe ſtones.

* Theſe gems are rather too precious to be examined by all poſſible experimental means; however they are, by reaſon of their hardneſs, and the particular form of their criſtals, with more propriety looked upon to be produced from their own ſeparate principle, being either formed in a ſingle drop, or criſtalliſed out of their matrix, rather than to be ranked among the quartz criſtals; for if the heat of the ſun, or the climate were the cauſe of the hardneſs of the diamonds, why is not a quartz criſtal on the coaſt of Barbary harder than one from the province of Jemtland in Sweden? and who can aſſure us here in Europe, if, at the place where the diamonds are dug, there is any kind of rock, or not, which is the baſis or matrix of theſe precious ſtones, in the manner as the quartz is of the rock or quartz criſtals? The account which Tavernier has given us, about the digging of diamonds at Golconda, agrees with that of the criſtals in Jemtland, viz. that they lye bedded in clay within cluſters of criſtals, and in clefts. Now ſuch of our criſtals are always the cleareſt, as have never been adherent to the rock, and next to them, ſuch, as by ſome unknown accidents in nature, have been ſeparated from their baſis; but ſuch, as are yet fixed to the rock, are very ſeldom fit for any uſe: if this, therefore, ſhould happen to be the caſe likewiſe with the diamonds, it is no great wonder, that they do not at the very place take any notice of the rock, and ſtill leſs, that they do not bring any of it to Europe. The cluſters or groupes of criſtal from Schneckenſtein in Saxony, wherein topazes and rock criſtals

SECT. XLIV.

B. Saphire, *Saphyrus gemma.*

It is tranſparent, of a blue colour, and is ſaid to be in hardneſs next to the ruby, or diamond.

are found promiſcuouſly mixed, having each their different forms, colours, and hardneſs, furniſhes a proof that nature forms the ſo called precious ſtones or gems, each from its particular matter or principle.

The round diamonds may be ſuppoſed to have undergone the ſame fate with ſome of the rock criſtals, viz. to have been, by changes in the earth, broken from their beds, and by the agitation of waters, ground and rubbed againſt one another, until they have been rounded or reduced to this form; ſince they are moſtly found amongſt ſand, and are diſcovered in places worn down by heavy ſhowers of rain.

The ruby is criſtalliſed into an octoëdral form, as well as the diamond *, and differs alſo very little from it in hardneſs and weight; I have, therefore, conſidered theſe two, as being of one and the ſame kind, and that with as much right as others, who have ranked them under the rock criſtals, which laſt are more regular than any other earthy ſubſtance, as they aſſume, during their criſtalliſation, a determined form, viz. the hexagonal, with a point at one or both ends.

A ſort of diamond is found, which is ſaid to be very ſoft, and is called the Jargon †, but this ſort is ſtill unknown to me, nor have I found that any experiments have been made relating to its hardneſs and principles.

I have ſeen in the collection of the mine-maſter, M. Van Swab, a diaphanous actoëdral criſtal of fluor, which, according to thoſe, who only mind the figure, ought to be called a Diamond.

* What I have obſerved about the octoëdral form of the diamonds, may alſo be applied to the rubies. Beſides, the rubies are alſo ſometimes found of irregular hexagonal figures. E.

† The Jargon, ſo called by the Engliſh jewellers. Its natural ſhape is not yet known, it being found in form of pebbles in the Indies, where it is ſplit into thin pieces, and thus ſent to Europe. The jargons are of different colours, viz. white, light yellow, and brown. According to ſome lapidaries, they come neareſt to the ſaphires in hardneſs; and as they have, when cut and poliſhed, a great reſemblance to the diamond, they are alſo by ſome called Soft Diamonds, and one may eaſily be impoſed upon in purchaſing theſe for true diamonds, when they are made up in any ſort of jeweller's work. E.

In consequence of the ignorance I plead in regard to these sorts of stones, I have given this a place by itself.

Saphires are said to be found in Alsatia, at St. Amarin, but accounts of this kind are in general not to be depended upon, as the fluors are frequently met with in collections and the druggists shops under the name of saphires, when they are of a deep blue colour; not to mention that the quartz is always termed a precious stone, whenever it is found clear, and of a fine colour. The saphire is said to lose its blue colour in the fire. Those which are but a little tinged are called white saphires. The saphire is seldom found of a very deep blue colour, and free from parallel flaws which run through it †.

SECT. XLV.

C. Topaz. *Topazius, gemma.*

This is a precious stone, which, when rough and perfect, is sold in a cristallised form

† The saphires in their rough or native state cristallize most generally like two oblong hexagonal pyramids pointed at their tops, and joined at their bases: yet they are sometimes found of an hexagonal columnar form. In the fire they lose their blue colour.

I have found some of the deep blue saphires, and some of a milky colour, which, when looked through, varied their colours in the same manner as the milky or bluish opals (Sect. iv. 2, 3.): this is however no reason why those opals should be ranked under the name of saphire, and less so, since there are also agats found of the same quality (Sect. lx. in the note) it might rather give rise to a question, whether the name of *milky or bluish opal* is not to be considered as a vague term, since that principal quality is found in stones of a somewhat different nature, tho' they all belong to the flinty order? E.

form. At Schneckenſtein in Saxony, theſe criſtals are found of a priſmatical octoëdral form, with no points, but flat, and with ſome facets at the top; however without doubt the oriental topazes have another figure *.

Experiments by fire have been made on the Schneckenſtein topazes by Mr. Pott, as may be ſeen in his *Lithogeognesia*.

To this kind I refer

a. The pale yellow topaz.

Which is nearly uncoloured, and is found at Schneckenſtein.

b. The yellow topaze, from Schneckenſtein.

c. Deep yellow, or gold coloured topaz, or oriental topaz.

d. Orange coloured topaz.

SECT. XLVI.

E. The yellowiſh green topaz, or *Chryſolite*.

Is of a graſs green colour, and may perhaps belong to ſome other ſpecies, which might be diſcovered, if it could be obtained rough, or in its matrix, and large

* I have got ſome rough Brazil topazes, which are priſmatical, and of a rhomboidal quadrangular figure, pointed at one end; but as theſe ſeem to be broke off at the other end, it is very likely, that they, as well as many other criſtals, may be pointed at both ends, when nothing has impeded them during their criſtalliſation.

Beſides theſe, I have got ſome fragments of other topazes, likewiſe ſaid to be from the Brazils, which are all of them priſmatical, but plainly ſhew, that ſome are pentagonal, and other regular hexagons with points.

The topazes loſe their colour in the fire, but ſome of them turn red in a certain degree of heat, and are therefore very much uſed inſtead of the pale rubies, and even are often ſold as ſuch.

enough

enough or in ſuch quantity as is neceſſary for experiments to be made.

F. The yellowiſh green and cloudy topaz, the *Chryſopraſe*.

This is perhaps the ſubſtance which ſerves as a matrix to the chryſolite: for thoſe I have ſeen of this kind are like the clear-veined, called in Swediſh milk criſtal, and quartz, which is of the firſt degree of criſtalliſation.

SECT. XLVII.

E. Bluiſh green topaz, or the Beryll.

This varies in its colours, and is called, when

1. Of a ſea-green colour, the *aqua marina*.
2. When more green, the Beryll.

They are found in the ſtream-works in Saxony and Bohemia, in form of pebbles, or round pieces.

SECT. XLVIII.

D. Emerald. *Smaragdus gemma*.

Its chief colour is green, and is tranſparent. I believe it to be, or to have been, a criſtal of its own ſeparate principle, ſince in its qualities it differs both from the above-mentioned, and from the rock-criſtals; but I cannot poſitively aſſert this, ſince I know no more of it, than that it is the ſofteſt of precious ſtones, and that, when heated, it is phoſphoreſcent, like the fluors; and what in ſome cabinets is given out for its matrix, and ſaid to come from Egypt, is nothing elſe than a deep green cockle-ſpar *, of which colour we likewiſe find cockle, or ſhirl, in the iſland of Uto, near Stockholm, and at Norbery, in the province of Weſtmanland.

Mr. Maillet informs us, that in former times the beſt emeralds were found in Egypt †.

SECT. XLIX.

Obſervations on the preceding bodies called, precious-ſtones, or gems.

I have before mentioned the reaſons, why I give theſe their ſeparate places from the following

* The original Swediſh has *Skiorl ſpat*, that is cockle or ſhirl ſpar, of which ſee fully Sect. lxxiii. infra. but the German tranſlation terms it, *ein Schoen ſpat*, a fine ſpar; that is to ſay, (in this ſenſe) a fine fluor. The ſchorl, or ſchirl, of the Germans, is a ſubſtance called by our Corniſh miners *Cockle*. I have therefore in my lectures on foſſils adopted the names of cockles or ſhirls for this ſubſtance in the Engliſh language, D. C.

† The emeralds, in their rough or native ſtate, conſiſt of hexagonal columns, moſtly truncated at both ends, though ſome of them now and then may be found facetted at the ends. I have ſamples of both tranſparent graſs-green, and light green, which in a gentle heat become colourleſs, but white and opaque in a ſtrong fire, without the leaſt mark of any fuſion.

When criſtalliſed cockle, or ſhirl, is found of a green colour, tranſparent, and free from cracks or flaws, it is commonly called emerald by the jewellers, though it is generally of a deeper colour than the true emeralds, and alſo wants its luſtre: and hence it is, that the cockle-ſpar from Egypt is called the mother of the emeralds.

However it may be, that this cockle was in antient times faſhionable in Egypt, under the name of emerald, though now-a-days it is not ſo much valued as the emerald of this (the ſiliceous) kind. See Section lxxv. Note under the cockle.

ſtones,

ſtones, among which they elſe might have been ranked equally as here, as they are already in other ſyſtems: to which I venture to add, that, as a naturaliſt, I cannot conquer that general weakneſs of valuing them ſo highly; for beſides their ſurpriſing hardneſs, and fine colours, that pleaſe the eye, it is not without foundation, that they might be thought applicable to every uſe for which the ſiliceous kind is employed, if they were to be had in large quantities: and by this alone it is they deſerve to have the preference of the other ſtones of this order. In regard to the colours, it is to be obſerved, that thoſe of the ruby and emerald are ſaid to remain in the fire, but that the colour of the topaz flies off: whence it is uſual to burn that gem on purpoſe that it may be made uſe of inſtead of the diamond, as it is harder than the quartz cryſtal. The colours of gems are commonly ſuppoſed to depend on metallic vapours: but may they not more juſtly be imagined to ariſe from a phlogiſton, united with a little metallic or ſome other earth? becauſe we find that metallic earths, which are perfectly well calcined, give no colour to any glaſs, and that the manganeſe, on the other hand, gives more colour than can be aſcribed to the ſmall quantity of metal which is to be extracted from it. (Section cxiii.)

The phlogiſton may perhaps have more difficulty to eſcape through the pores of the hardeſt of the precious ſtones, if it is true, that the property of loſing the colour is in proportion to their hardneſs, as ſome authors ſeem to indicate, by aſſuring us, that none but the coloured diamonds and the rubies keep their colours in the fire; but in this circumſtance I likewiſe want experience, but hope to ſee it illuſtrated by thoſe who may happen to get an opportunity of diſcovering the true methods to deliver the world from the many ambiguities and diſtinctions, which have been made on this ſubject, and which perhaps are all formed upon as great reaſon, as thoſe we ſtill uſe in diſtinguiſhing the oriental and occidental gems, which ſignifies in other words, no more than hard and clear, or ſoft and flawy, deeper or paler, or of good or bad colours *.

* To the precious ſtones belong alſo the jacinths, or hyacinths, which are criſtals harder than quartz criſtals, tranſparent, of a fine reddiſh yellow colour, when in their full luſtre, and formed in priſms pointed at both ends: theſe points are always regular, in regard to the number of the facets, being four on each point, but the facets ſeldom tally: the ſides alſo, which form the main body, or column, are very uncertain, in regard both to their number and ſhape, for they are found of four, five, ſix, ſeven, and ſometimes of eight ſides: further, the column or priſm is in ſome alſo ſo compreſſed, as almoſt to reſemble the face of a ſpherical facetted garnet. Theſe criſtals loſe their colour, become white, and do not melt in the fire, by which qualities chiefly they may be diſtinguiſhed from garnets, (Section lxviii. 3.) which are likewiſe ſometimes found of a colour not inferior to the true jacinths. The author had not, at the time when he wrote this Eſſay, ſeen the true jacinths, but mentions in Section lxix. *C. c.* that the reddiſh yellow garnets from Greenland, are ſold by the jewellers for jacinths; ſo are likewiſe the Eaſt Indian garnets of the ſame colour, and, what is ſtill more, there are ſome jewellers that do not know the true diſtinctions between a jacinth and a garnet at all, but buy and ſell the garnets for jacinths, when they are of a fine reddiſh yellow colour: this muſt in particular be owing to the ſcarcity of the true jacinth.

Mr. Cronſtedt has ſince informed me by letter, that he had lately got ſome jacinths of a quadrangular figure, which did not melt in the fire, but only became colourleſs; this confirms what I have already mentioned about the jacinths I tried, and which are above deſcribed. E.

SECT.

SECT. L.

E. Quartz. *Quartzum**.

This ſtone is very common in Europe, and eaſier to be known than deſcribed. It is diſtinguiſhed from the other kinds of the ſiliceous order, by the following qualities.

1. That it is moſt generally cracked throughout, even in the rock itſelf, whereby
2. As well as by its own nature, it breaks irregularly, and into ſharp fragments.
3. That it cannot eaſily be made red hot, without cracking ſtill more.
4. It never decays in the air
5. Melted with pot-aſhes, it gives a more ſolid and fixed glaſs than any other of the ſiliceous order.
6. When there has been no interruption in its natural accretion, its ſubſtance always criſtalliſes into hexagonal priſms, pointed at one or both ends.
7. It occurs in clefts, fiſſures, and ſmall veins in rocks. It very ſeldom forms large veins, and ſtill ſeldomer whole mountains, without being mixed with heterogeneous ſubſtances.

SECT. LI.

The Quartz is found,

1. Pure, *Quartzum purum.*

   A. Solid, of no viſible particles with a gloſſy ſurface. *Particulis impalpabilibus ſuperficie polita.* Fat Quartz.

* I ſhall adopt this name of quartz in Engliſh as it has already gained acceſs into the other European languages. D. C.

a. un-

a. Uncoloured and clear, *Diaphanum.*

Is found in the copper mines in the north part of Norway, and in Siberia. This has no criftallifed form, but is neverthelefs as clear as quartz criftals of the beft water.

b. White, the common fat quartz.

c. Blue, from the ifland of Uto in the province of Sodermanland.

d. Violet, from the ifland of Uto.

B. Grained, *Textura granulata.*

a. White, from the gold mines at Adelfors in the province of Smoland, and the copper mines at Lovifeberg in Weftmanland.

b. Pale green, from Adelfors.

C. Sparry quartz, *Textura fpatofa.*

This is the fcarceft, and ought not to be confounded with the white Felt-fpat Sect. lxvi. being of a fmoother appearance, and breaking into larger and more irregular planes.

a. Whitifh yellow, from the gold mines in Hungary.

b. White, from the ifland of Uto.

SECT. LII.

D. Criftallifed Quartz, *Quarzum criftallifatum.* Rock criftal. Quartz criftal. *Criftallus montanus.*

Its figure is already (Sect. L) defcribed, and, in regard to the colours, the following varieties occur.

1. Opaque, or femi-tranfparent, *Criftallus opacus vel femi-diaphanus.*

a. White, or of a milk colour.

b Red

b. Red, or of a carnelian colour, from Oran in Barbary.

c. Black, from the ſame place.

2. Clear, *Diaphanus.*

a. Blackiſh brown, ſmoaky topaz, or *Raunch Topas* of the Germans, is found at Egern in Norway, and at Loviſa in Finland.

b. Yellow, found in Bohemia, and ſold inſtead of topazes.

c. Violet, the amethiſt, from Saxony, Bohemia, and Dannemora in Upland.

d. Uncoloured, Rock Criſtal, properly ſo called, from Bohemia: alſo from the province of Jemtland, and many other places; when theſe coloured criſtals are not clear, they are called Fluſs, for inſtance Topaz-Fluſs, Amethiſt-Fluſs, &c. &c.

SECT. LIII.

2. Impure Quartz, *Quartzum heterogeneis intimè mixtum.*

A. Mixed with iron, in form of a black calx, *Quartzum calce ferri atro intrinſece mixtum.* This is black, of a gloſſy texture, and contains a great quantity of iron.

It is found at Staf's iron mine in Sodermanland, and at Gierdeſioſtrand in the pariſh of Offerdal in Jemtland, at which laſt place the iron alſo diſcovers itſelf by its ruſt in the cracks of the ſtone.

B. Mixed with copper in form of a red calx, *Quartzum croco Veneris mixtum.*

Red

Red, and is found in Sunnerſkog's copper mine in the province of Smoland *.

SECT. LIV.

F. The Flint, *Silex pyromachus. Lapis corneus,* or *Hornſtein* of the Germans.

This is equally common with the Quartz, and it is full as difficult to deſcribe it; eſpecially as it forms a kind of intermediate ſubſtance between Quartz and Jaſper, both

* That the colour in theſe latter bodies depends on metals, is eaſily proved by metallurgical Eſſays, and the reſemblance they have with compoſitions of glaſs, made on the ſame principle; but the ſame cannot be affected of the precedent coloured quartzes (Sect. li. lii.), before it be evidently demonſtrated.

It is very likely, that a quartz may be found which is intimately mixed with a calcareous earth, and ſuch is, perhaps, the Hungarian ſparry quartz (Sect. li. *C.*), which, however, I recommend for further examination.

The quartz in general, and eſpecially its criſtals, are very commonly thought, when yet in their ſoft or diſſolved ſtate, to have included within them ſome vegetables, for inſtance, graſs and moſs. This I cannot abſolutely deny, but I muſt at the ſame time obſerve, that it deſerves to be carefully examined, if that, which is ſhewn as a graſs, be not an aſbeſtos, or a ſtriated cockle, and the moſs, only branched vacuities filled with earth, which, by their being ramoſe, bear a vegetable appearance: it is very common in agates, and makes them of leſs value than otherwiſe they would be; this is moſt generally the caſe with thoſe ſtones, which are ſhewn as including vegetables, and for my own part I have never been ſo fortunate as to meet with any others.

When the rock criſtals are ſemi-tranſparent, or intermixed with opaque veins, they are, by the Swediſh lapidaries, called Milk criſtals; when they are found in form of round pebbles, which is occaſioned by their being toſſed about and rubbed againſt one another by floods, or by the ſea, they are called by the Engliſh lapidaries, Pebble cryſtals. They come from the Indies, Siberia, and other places, but theſe cannot be ranged ſeparately, for evident reaſons, or otherwiſe for reaſons already mentioned in their proper places.

which

which it ſo nearly reſembles, that it is not eaſy to point out ſuch characters as ſhall readily diſtinguiſh it from them. The beſt way, perhaps, will be to ſpeak of its properties comparatively; and then we may ſay that,

1. It is more uniformly ſolid, and not ſo much cracked in the maſs as the quartz; and,
2. It is more pellucid than the jaſper.
3. It bears being expoſed to the air, without decaying, better than the jaſper, but not ſo well as the quartz.
4. It is better for making of glaſs than the jaſper, but is not quite ſo good as quartz for that purpoſe.
5. When ever there has been an opportunity in this matter of its ſhooting into criſtals, quartz criſtals are always found in it; juſt as if the quartz had made one of its conſtituent parts, and had on certain circumſtances been ſqueezed out of it; this is to be ſeen in every hollow flint, and its clefts, which are always filled up with quartz.
6. It often ſhews moſt evident marks of having been originally in a ſoft and ſlimy ſtate.

The ſeveral varieties of this ſpecies have obtained diſtinct names, more with reſpect to their colours, than from any real difference in their ſubſtance; but theſe are ſtill neceſſary to be retained, as the only names uſed by jewellers and others, who know how to value them accordingly.

SECT.

SECT. LV.

1. The Opal. *Opalus Pæderota.*

It is the moſt beautiful of all the flint kind, owing to the changeable appearance of its colours by reflection and refraction, and muſt therefore be deſcribed under both theſe circumſtances.

a. The Opal of Nonnius, the Sangenon of the Indians.

This appears olive-coloured by reflection, and ſeems then to be opaque, but when held againſt the light, is found tranſparent, and of a fine ruby red.

That opal is ſuppoſed to have been of this kind, which Pliny mentions in his Natural Hiſtory, chap. 307. ſect. xxi and which he ſays, was in the ſenator Nonius's poſſeſſion, who rather ſuffered baniſhment, than part with it to Antony.

This ſtone was in Rome at that time valued at 20000 ſeſterces. But the ſtone here particularly deſcribed, was found in the ruins of Alexandria; it is about the ſize of a hazle-nut, and was bought for a trifle of a French druggiſt, named Roboly, and preſented to the French general conſul Lironcourt, who afterwards offered it to ſale in ſeveral places, for the ſum of 40,000 rixdollars. See Haſſelquiſt's Travels to the Eaſt, under the article of Opal. *

* This very ſtone was in the year 1763 in the poſſeſſion of his excellency the duke de Nivernois, then ambaſſador to the Britiſh court, and I have often been honoured by his excellency of having it for ſome days in my poſſeſſion. D. C.

There

There is, however, another of the ſame kind in Sweden, which by reflection appears rather brown; but by refraction is red, with violet veins.

b. The white opal. Its ground is white, of a glaſs-like complexion, from whence are thrown out green, yellow, and bluiſh rays; but it is of a reddiſh or rather flame colour, when held againſt the light.

1. Of many colours. The oriental opal.
2. Of a milky colour *, from Eibenſtock, in Saxony.
3. Bluiſh, and ſemi-tranſparent. This is not ſo much valued, as thoſe which are

* I have lately got a ſmall piece of pſeudo-agate, from the Eaſt-Indies, which is of a yellowiſh brown, and pale blue, or rather milky colour, with a ſhining brightneſs, exactly like that of the milky opals of this ſection, and received alſo ſome other ſpecimens found at St. Georgio, near Turin, in Piedmont, there called by the name, *Pſeudo agate* (Baſtard agate), a name which ſeems very well adapted to this ſtone, ſince in every reſpect, hardneſs excepted, it comes neareſt to the agates; becauſe, 1. It is tranſparent in the ſame degree as agates, and varied with red and grey colours, interſperſed ſometimes with white opaque veins, or rings, and black dendritical figures. 2. It is of a very fine and ſhining texture, when broke, rather ſuperior to that of the agates, but ſo ſoft, that it ſcarce yields any ſparks, when ſtruck againſt ſteel; and does not admit of any poliſh, but what is inferior to the luſtre of its natural texture: however, it ſlightly marks common window glaſs. 3. When broke through the dendrites, it is as ſmooth and ſhining at that place as in any other; and theſe dendrites vaniſh in the fire, without leaving any pores in the ſtone. 4. It does not melt before the flame, by the blow-pipe, but becomes perfectly white and opaque. 5. Nor is it fuſible even with borax. 6. It does not ferment with the acid of nitre.

more opaque, becauſe it is eaſier to be imitated by art †.

SECT LVI.

The Cat's Eye. *Pſeudopalus*.

This ſtone is opaque, and reflects green and yellowiſh rays from its ſurface, and is found in Siberia *.

Sometimes this ſtone is ſurrounded with a white cruſt, like common flints in the ſtrata of chalk; which cruſt has likewiſe the ſame effect as that of the flint, when this laſt-mentioned has been previouſly freed from the adherent chalk; viz. 1. It does not ferment nor diſſolve in the acid of nitre; 2. is not fuſible by itſelf in the fire; 3. but melts pretty eaſily with borax, though without any effervescence, contrary to what we obſerve with calcareous ſubſtances; and thus borax will diſſolve a quantity equal to about three quarters of its own bulk, thg h not without difficulty, eſpecially towards the end of the operation; but the glaſs becomes quite clear and colourleſs, inſtead of growing white and opaque, as with calcareous ſubſtances. E.

† Not only this, but alſo ſome of the other kinds of opals, have been well imitated by art, there being found compoſitions of glaſs, which ſhew very different colours by refraction from what appear by reflection. A curious antient one of this kind is to be ſeen in the Royal Abbey of St. Dennis, near Paris, which is green on the outſide, and ſhews a fine ruby colour when viewed againſt the light. And lately an ingenious gentleman at London made ſome paſtes, which are of a yellowiſh dark brown by reflection; but ſome of which, when held againſt the light, appear of a fine blue colour, and others either purple, or like hyacints, garnets and rubies.

* The earlier writers on ſtones mention other varieties of this kind; for inſtance, the *Oculus Mundi* §, which, after hav-

§ There are in the Britiſh Muſæum at London, three of theſe ſtones called *Oculus Mundi*. The largeſt of them is about the bigneſs of a cherry-ſtone, though in an oval form. It is opaque, and its colour like that of a common yellow pea; it may be ſcratched, though not without difficulty, by a knife; it ſeems however to leave a mark on common glaſs, and does not ferment with the acid of nitre.

When it has lain in water ſome hours, it becomes tranſparent, and of a yellow amber colour. This change begins ſoon after the immerſion, and at one end, in form of a little ſpot (but in a ſmall one of the ſame

kind

SECT. LVII.

3. The Onyx. *Onyx Camehuja.* Memphites.

This ſtone is the hardeſt of the flinty tribe, and conſiſts of differently coloured veins, which run parallel to one another, ſometimes in ſtraight, ſometimes in curved lines. It is found of two ſorts.

a. Nail-coloured onyx, having pale fleſh-coloured, and white lines. From the river Tomm in Siberia.

b. With black and white lines. The Oriental onyx.

The old Romans were accuſtomed to cut figures on the ſtraight-lined onyxes in relief, which they called *Camehuja*; theſe are ſtill counterfeited, and called Camayeu. Thoſe which conſiſt of concentric circles were called Memphites; and we have now of this kind cut to be ſet in

ing been laid in water, ſhines like a piece of red-hot charcoal; the Aſteria, which is ſaid to ſhew luminous ſtars on its ſurface, &c. But theſe are no longer to be met with, ſince faſhion has given preference to the more tranſparent hard ſtones; and it is alſo very difficult rightly to underſtand the deſcriptions of antient authors, in regard to colours, and their different mixtures with one another ‡.

kind the beginning is round the edges) which increaſes by ſlow degrees until the whole ſtone is become uniformly clear throughout: when taken out of the water, it loſes its tranſparency, firſt at one end, then gradually over the remainder, until the whole ſtone has recovered its former opacity; and this change happens in leſs time than that of its becoming tranſparent. No other experiments have yet been made upon this ſtone, becauſe it is ſo very ſeldom to be met with; and theſe are not ſufficient to determine exactly of what kind it is. E.

‡ Amongſt theſe cannot be reckoned the Tourmaline, ſo much renowned of late for its electrical qualities. It is but a cryſtalliſed cockle, of a green or brown colour, more or leſs deep, ſo as to turn to a black, and ſometimes to a bluiſh colour, when looked through; others appear quite black. [See Sect. LXXV.) E.

The Braſilian emerald ſeems to have the ſame properties of becoming electrified poſitively in one ſide, and negatively in the other: it belongs alſo to the Shirl kind. [See Sect. XLVIII, Note †.]

F rings,

rings, under the name of *Occhi di Gatti*, which, however, ought not to be confounded with the pseudopal, (Sect. lvi.) or cat's-eye.

SECT. LVIII.

4. The Chalcedony, or white agate.

I a flint of a white colour, like milk diluted with water, more or less opaque: it has veins, circles, and round spots. It is said to be softer than the onyx, but much harder than those agates which are sometimes found of the same colour.

a. The white opaque Chalcedony, or *Cacholong*, from the Buckarish Calmucks. This was first made known by one Renez, a Swedish officer, who for several years had been in that country. The inhabitants find this flint on the banks of their rivers, and work idols and domestic vessels out of it.

b. Of white and semi-transparent strata, from Ceylon.

c. Bluish grey, from Ceylon and Siberia.

SECT. LIX.

5. The Carnelian, *Carniolus*.

Is of a brownish red colour, and often entirely brown. Its name is originally derived from its resemblance to flesh, or to water mixed with blood.

a. Red, from the East, and Turky.

b. Yellowish brown, looks like yellow amber, from the river Tomm, in Siberia. It is said not to be so hard as the Chalcedony.

SECT.

SECT. LX.

6. The Sardonyx.

Is a mixture of the chalcedony and carnelian, ſometimes ſtratum-wiſe, and ſometimes confuſedly blended and mixed together.

a. Striped with white and red ſtrata: this ſerves as well cut in cameo as the onyx.

b. White, with red dendritical figures.

This very much reſembles that agate which is called the Mocha ſtone, but with this difference, that the figures are of a red colour in this, inſtead of black, as in that agate.

I have unwillingly diſtinguiſhed the onyx, carnelian, chalcedony, ſardonyx, and agate, as ſeparate ſpecies, ſince there is no real difference between them, except ſome inexplicable degrees of hardneſs; but I have been induced to continue theſe names for the reaſons before given in Sect. liv.

SECT. LXI.

7. The Agate, *Achates.*

This name is given to flints that are variegated with different colours, promiſcuouſly blended together; and they are eſteemed in proportion to their mixture of colours, their beauty and elegance. Hence alſo they have obtained variety of names, moſtly Greek, as if the buſineſs of the lapidary in cutting of them, and admiring their ſeveral beauties and figures, had been derived from that nation alone.

As it ever was and muſt be very difficult to give intelligent deſcriptions of colours, ſo we are quite at a loſs to underſtand the meaning of the antients in this reſpect; but this indeed is of little conſequence, as we ſeem to have the ſame right, under the ſame circumſtances, of inventing new names for them; and that in whatever language we pleaſe. Nevertheleſs I have deſcribed ſome few varieties of thoſe which at this time are the moſt common, to ſerve as inſtances.

a. Brown opaque agate, with black veins, and dendritical figures, the Egyptian pebble.

b. Of a chalcedony colour, *Achates chalcedoniſans.*

c. Semi-tranſparent, with lines of a blackiſh brown colour, and dendritical figures, the Mocha ſtone.

This is much eſteemed, and makes a valuable part of ſome collections, where it has a place chiefly for the ſake of its figures, reſembling vegetables, animals, &c. which however are often improved by art.

d. Semi-tranſparent with red dots, *Gemma divi Stephani.*

When the points are very minute, ſo as to give the ſtone a red appearance, it is by ſome called *Sardea.*

e. Semi-tranſparent, with clouds of an orange colour.

f. Deep red or violet, and ſemi-tranſparent.

g. Of many colours, or variegated.

h. Black.

There

There is in Europe great quantities of moſt varieties of agates *, particularly at Oberſtein in the Palatinate, where they are cut and poliſhed: but they are likewiſe found in every part of the world. In Sweden there is not yet, as far as I know, more than one ſpecies of agate found; namely, at Gaſebeck, in the province of Skone, which is of a white and deep red colour.

SECT. LXII.

8. Common Flint, *Silex communis Pyromachus.*

Is really of the ſame ſubſtance as the agate; but as the colours are not ſo ſtriking

* I have lately got a ſpecimen of a hollow agate ball, with pale améthiſts in the inſide, between which is cryſtalliſed a calcareous ſubſtance into a fibrous form. Theſe fibres are parallel, white, ſhining, and very minute, exactly reſembling the fineſt aſbeſt, for which it alſo might be miſtaken, if it was to be judged only by the eye. But by experiment it is found neither to be an aſbeſtus nor a gypſum, which ſometimes ſhoot alſo into a fibrous form, but entirely a pure calcareous ſubſtance. The whole maſs does not adhere together, but is nearly divided into ſmall triangles, which are placed upon one another, ſo as almoſt to form a large figure of the ſame kind. Theſe fibres however, although very minute, may be found by means of a proper manifying-glaſs, to be of an angular figure, like thoſe mentioned in the note at page 82. The ſhape of balls and irregular nodules, is the moſt general form in which agates and flints are commonly found. Nevertheleſs, beſides what I have ſeen in ſeveral collections in London and abroad, I have likewiſe ſome ſpecimens of native ſilver, from Potoſi, in the Spaniſh Weſt Indies, which run in a grey and blue tranſparent agate, with white opaque veins; which ſeems to confirm the opinion, that agates may form veins in the rocks, as well as other ſorts of ſtones. [See the note of Sect. LXIII.] E.

or agreeable, it is commonly conſidered as a different ſubſtance.

a. Blackiſh grey, from the province of Skone.

b. Yellow ſemi-tranſparent, from France.

c. Whitiſh grey.

d. Yellowiſh brown.

When the flints are ſmall, they are in England called pebbles; and the Swediſh ſailors, who take them as ballaſt, call them *ſingel.*

SECT. LXIII.

9. Chert, *Petroſilex*, *Lapis Corneus*. The *Hornſtein* of the Germans.

Is of a coarſer texture than the preceding, and alſo leſs hard, which makes it conſequently not ſo capable of a poliſh. It is ſemi-tranſparent at the edges, or where it is broke into very thin pieces.

a. Chert of a fleſh colour, from Carl-Schakt, at the ſilver-mine at Salberg, in the province of Weſtmanland.

b. Whitiſh yellow, from Salberg.

c. White, from Kriſtiersberg, at Nya Kopparberget, in Weſtmanland.

d. Greeniſh, from Preſtgrufvan, at Hellefors in Weſtmanland *.

* There are not yet any certain characters known, by which the Cherts and Jaſpers may be diſtinguiſhed from each other: by ſight, however, they can eaſily be diſcerned, viz. the former, or chert, appearing ſemi-tranſparent, and of a fine ſparkling texture, on being broken; whereas the jaſper is grained, dull, and opaque, and has exactly the appearance of a dried clay: the chert is alſo found forming larger or ſmaller veins, or in nodules like kernels in the rock; whereas the jaſper, on the contrary, ſometimes conſtitutes the chief ſubſtance of the higheſt and moſt extended chains of

of mountains. The chert is likewise found plentifully in the neighbourhood of scaly limestone, as flint is in the strata of chalk. What connexion there may be between these bodies, perhaps time will discover.

But flints and agates being always found in loose and single irregular nodules, and never in rocks, as the chert, is a circumstance very insufficient to establish a difference between them; for there is agate near Constantinople running vein-like across the rock with its country, of the same hardness, and as fine and transparent as those other agates, which are found in round nodules at Deux Ponts. We must therefore content ourselves with this remark concerning flints, That they seem to be the only kind of stone hitherto known, of which a very large quantity has been formed in the shape of loose or separate nodules, each surrounded with its proper crust; and that the matter which constitutes this crust, has been separated from the rest of the substance in like manner as sandiver, or glass gall, separates from, and swims upon glass during its vitrification; tho' sometimes the formation of this crust may have been prevented by the too sudden hardening of the matter itself: I shall therefore take the liberty to call this matter of the crust, which sometimes is an indurated terre verte, by the name of *Agate-gall*.

Other species of stones, which are found in loose pieces, or nodules, except ores, and some sorts of stalactites, shew evidently by their cracks, angles, and irregular figures, that they have been torn from rocks, rolled about, and rubbed against one another in torrents, or by some other violent motions of water. That flints have originally been in a soft state, as I have mentioned, is easy to be seen in the Egyptian pebbles, which have impressions of small stones, sand, and sometimes perhaps grass, which however have not had any ingress into the very flint, but seem only to have forced the abovementioned agate gall or crust out of the way †.

SECT. LXIV.

G. Jasper, *Jaspis*.

All the opaque flints are called by this name, whose texture resembles dry clay, and which have no other known quality, whereby

† The erroneous notion of the once soft state of stones, see discussed in my First Lecture on Fossils. D. C.

they may be diſtinguiſhed from other flints, except that they may be more eaſily melted in the fire; and this quality perhaps may proceed from ſome heterogeneous mixture, probably of iron.

1. Pure jaſper, *Jaſpis purus.*
   Which by no means yet known can be decompounded.
   a. Green with red ſpecks or dots, the *Heliotrope*, or blood-ſtone, from Egypt.
   b. Green, from Bohemia.
   c. Red, *Diaſpro roſſo Italorum.*
   d. Yellow.
   e. Red with yellow ſpots and veins, *Diaſpro florido* of Sicily, Spain, and Conſtantinople.
   f. Black, from Finland, and Neſkott, in the province of Jemtland.

SECT. LXV.

2. Jaſper containing iron, *Jaſpis martialis, Sinople.*
   A. Coarſe grained.
   a. Red and reddiſh brown, *Sinople*, from the Hungarian gold mines.
   B. Steel grained, or fine grained.
   a. Reddiſh brown, from Altenberg, in Saxony; looks like the red ochre or chalk uſed for drawing, and has partition veins, which are unctuous to the touch, like a fine clay, and other like kinds.
   C. Of a ſolid and ſhining texture, like a ſlag.
   a. Liver-coloured, and
   b. Deep red. Both theſe are found at

Lang-

Langbanſhyttan in the province of Wermeland, and at Sponwik in Norway.

c. Yellow, from Bohemia.

This laſt mentioned, when calcined, is attracted by the load-ſtone, and being aſſayed, yields 12 to 15 per cent. of iron.

* Jaſper, when freſh broke, ſo nearly reſembles a bole of the ſame colour, that it can only be diſtinguiſhed by its hardneſs. In the pariſh of Orſa, in the province of Dalarne, there is a red bole found in ſpaces like glands or kernels, in that ſort of ſandſtone from which grindſtones are cut; and ſome miles diſtant, in the rocks at Serna, a red jaſper of the ſame colour and texture as the above bole, is found in a much harder kind of ſandſtone. In other places jaſper is found in ſuch unctuous clefts, as if they had contained unctuous clays; as pipe clays, and red chalk: and there are likewiſe ſome jaſpers which imbibe water. May it not then be ſuppoſed with ſome probability, that jaſper is an indurated bole, a reddle, or terre verte? That jaſper, as well as theſe, conſiſts of clay and iron; though, by reaſon of its being hardened, it becomes as difficult to extract theſe principles from it, as to reduce a ſmall quantity of ſcorified iron to its metallic form, when melted with a large quantity of ſlag or glaſs? That the ſame bole or clay, together with another ſubſtance, perhaps lime, after being diſſolved by a menſtruum, not yet determined, is ſufficient for the production of flint ſtone? and that ſo much of the bole as was ſuperfluous, being ſeparated from the maſs, is found adhering to the ſurface, or in the fiſſures, &c.

Thus one might imagine, that jaſper could eaſily be produced, and that the ſoft kinds might become harder by length of time; but its particles cannot be ſuppoſed to approach nearer and nearer to one another during the hardening; nor can it be imagined, that the jaſper ſhould by that means become of a finer texture. On the other hand, we know extremely well, and have the experience of it every where, that porphyry in the rocks decays into a white cruſt, wherever it is expoſed to the air, although internally it remains very hard and black; for inſtance, at Klitten, in Elfdalen, in Sweden. From whence it may be ſuppoſed, that water, which waſhes off the mouldered particles, muſt by degrees collect them ſomewhere, and at length preſent us

 with

SECT. LXVI.

H. Rhombic Quartz, *Spatum ſcintillans Felt-ſpatum* *.

This has its name from its figure †, but ſeems to be of the ſame ſubſtance as the jaſper. I have not however ranked them together, for want of true marks to diſtinguiſh the different ſorts of the flinty tribe from one another.

This kind is found,

1. Sparry.
   a. White.
   b. Reddiſh brown, occurs in the Swediſh and alſo in the foreign granites.
   c. Pale yellow.
   d. Greeniſh.

   This laſt mentioned reſembles very much the ſchorl or cockle-ſpar, (Sect. lxxiii.) but is neither ſo eaſy to melt in the fire, nor of ſo exact a figure.
2. Criſtalliſed.

with them in form of an earth, which perhaps we do not know in that ſtate. It may be aſked, Whether this earth will be ductile as clay, or rough to the touch as powder of bricks? Perhaps Tripoly is produced in this manner.

* The Germans and other nations call this ſubſtance Feld-ſpat, that is feild or vague ſpar; a name very inadequate to its nature, as it touches no wiſe on the ſparry claſs. I have therefore, in my Lectures, given it the Engliſh name of Rhombic Quartz, a name very ſignificant, as the name quartz expreſſes its claſs; and the quality of it, of always breaking into angular (rhombic) fragments, is alſo expreſſed by the adjective of rhombic. D. C.

† What Cronſtedt means, that the feld-ſpat has its name from its figure, is unintelligible. D. C.

A. In ſeparate or diſtinct rhomboidal criſtals, from the iron mine called Moſſgrufvan, at Norbery in Weſtmanland *.

SECT. LXVII.

Observation on the Siliceous's Order.

The œconomical uſes of this order are not ſo manifold as thoſe of the Calcareous and Argillaceous claſſes; however, moral reflections laid aſide, it will be neceſſary briefly to mention how far this order is conſidered and employed in common life.

The Europeans have no farther trouble with the precious ſtones, than either to cut them from their natural or rough figure, or to alter them, when they have been badly cut in the Indies; in which latter circumſtance they are called *Labora:* and it may be obſerved, that for cutting the ruby, ſpinell, ballas, and chryſolite, the oil of

* This ſpecies is very ſeldom found alone in form of veins, and ſtill more rarely as conſtituting the ſubſtance of whole mountains; but is generally mixed either with quartz and mica, as in the granites, or with jaſper, having ſome occaſional concurring particles of quartz, cockle, and hornblende, as in the porphyry. If the rhombic quartz and jaſper were of the ſame ſpecies, that ſort of porphyry which is made up of theſe two bodies only, ought to be ranked among the jaſpers, inſtead of being placed with the Saxa in my Appendix, Sect. cclxvi.

It is however obſervable on old monuments, which are expoſed to the open air, that though the porphyry has decayed, and conſequently loſt its poliſh, yet granite of the ſame age, compoſed for the moſt part of rhombic quartz, has kept its luſtre. This, however, does not contradict the poſſibility of rhombic quartz being of the ſame ſubſtance as the jaſper; becauſe the calcareous ſpar is found to bear the weather, and even fire, better than the limeſtone.

vitriol

vitriol is required, inftead of any other liquid, to be mixed with the diamond powder.

If the petty princes in thofe parts of the Indies where precious ftones are found, have no other power nor riches proportionable to the value of thefe gems; the reafon of it is as obvious as of the general weaknefs of thofe countries where gold and filver abound, viz. becaufe the inhabitants, placing a falfe confidence in the high value of their poffeffions, neglect ufeful manufactures and trades, which by degrees produces a general idlenefs and ignorance thro' the whole country.

On the other hand, perhaps fome countries might fafely improve their revenues by fuch traffic. In Saxony, for example, there might probably be other gems found, befides aquamarines and topazes; or even a greater trade carried on with thefe than at prefent, without danger of bad confequences; efpecially under the direction of a careful and prudent government.

The half precious ftones, fo called, or gems of lefs value, as the opal, the onyx, the chalcedony, the carnelian, and the coloured and uncoloured rock criftals, have been employed for ornaments and œconomical utenfils, in which the price of the workmanfhip greatly exceeds the intrinfic value of the ftones. The antients ufed to engrave concave or convex figures on them, which now-a-days are very highly valued, but often with lefs reafon than modern performances of the fame kind. Thefe ftones are worked by means of emery on plates of lead, copper, and tin, or with other inftruments; but the common work on agates is performed at Oberftein, with grindftones, at a very cheap rate. When once fuch a manufac-

manufactory is eſtabliſhed in a country, it is neceſſary to keep it up with much induſtry and prudence, if we would wiſh it to ſurmount the caprice of faſhions; ſince how much ſoever the natural beauty of theſe ſtones ſeems to plead for their pre-eminence, they will at ſome periods unavoidably ſink in the eſteem of mankind, but they will likewiſe often recover, and be reſtored to their former value.

The grindſtones at Oberſtein are of a red colour, and of ſuch particular texture, that they neither admit of any poliſh, nor are they of too looſe a compoſition.

Moſt part of the flinty tribe is employed for making glaſs, as the quartz, the flints and pebbles, and the quartzoſe ſands. The quartz, however, is the beſt; and, if uſed in due proportion with reſpect to the alcali, there is no danger of the glaſs being eaſily attacked by the acids; as has ſometimes happened with glaſs made of other ſubſtances: for inſtance, of bottles filled with Rheniſh and Moſelle wines, during the time of a voyage to China.

In the ſmelting of copper ores, quartz is uſed to render the ſlag glaſſy, or to vitrify the iron; quartz being more uſeful than any other ſtone, to regain or revive this metal.

The preſence of the quartz in the rock-ſtones, (Sect. cclxii.) and alſo in crucibles, and ſuch veſſels, contributes moſt of all to their power of reſiſting the fire: it appears likewiſe probable, that the quartzoſe matter makes the grind and whetſtones fit for their intended purpoſes.

SECT.

SECT. LXVIII.

The THIRD ORDER.

The Garnet Kind, *Terræ Granateæ*.

The matter composing the ſubſtance of garnet, and ſchorl or cockle, except that ſmall portion which is metallic, does in its indurated ſtate reſemble the ſiliceous tribe, ſo far as relates to external appearance and hardneſs; and therefore I would willingly have followed the opinion commonly received, of conſidering theſe two ſubſtances as ariſing from one another, if I had not been perſuaded to the contrary by the following qualities of the garnet.

1. It is more fuſible, in proportion as it contains leſs metallic matter, and is more tranſparent or glaſſy in its texture; which is quite contrary to the ſiliceous kind.
2. This is the reaſon, perhaps, why the garnet, mixed with the ſalt of kelp, may on a piece of charcoal be converted to a glaſs by the blow-pipe, which cannot be done with the flints: and,
3. Why the moſt tranſparent garnet may, without any addition, be brought to a black opaque ſlag by the ſame means.
4. It is never, ſo far as is hitherto known, found pure, or without ſome mixture of metal; and eſpecially iron, which may be extracted by the common methods.
5. The garnet matter, during the criſtalliſation, has either been formed in ſmall detached quantities, or elſe has had the power of ſhooting into criſtals, though cloſely

closely confined in different substances: since garnets are generally found dispersed in other solid stones, and oftentimes in the harder ones, such as quartz and chert *.

SECT. LXIX.

1. Garnet, *Granatus.*

Which is a heavy and hard kind of stone, cristallising in form of polygonal balls, and is mostly of a red, or reddish brown colour.

A. Garnet mixed with iron, *Granatus martialis.*

* It is certain, that the metallic calces being mixed with other earthy substances, make great alteration in respect to their fusibility; and we know from experience, that the presence of iron in the argillaceous, and most particularly in the micaceous kinds, renders them fusible; however, though there may be good reasons for considering the garnet as a quartz impregnated with iron; yet as quartz becomes less fusible by any addition of iron, of which the Swedish *Torrstén,* (Sect. ccxiii. in the note) a martial ore, commonly mixed with quartz, is an instance; and as even the species of quartz naturally mixed with that metal, (Sect. liii. *A.*) are far less easily fusible than the garnet; it might perhaps be better to call the garnet a stone of a different order, until by sufficient experiments we may have reason to reduce the number of the earths. Though if we should ever arrive at an exact method of classing in this respect, perhaps the œconomical use of these bodies will rather require such a distribution of them as shall more regard their present existence, than that which they have been originally derived from.

The garnet earth, so far as I know, is not yet found, but in an indurated state; and, as such, it is divided into the garnet, and into shirl or cockle, and that in regard to the figure of their cristals, more than any thing else: though their colour has also had some share in this division. I have here followed custom, which, perhaps, may have some reason, however ill founded it be.

1. Coarse

1. Coarſe grained garnet ſtones, without any particular figure, *Granatus particulis granulatis ſigura indeterminata*; in Swediſh called *Granat-berg*; in German *Granatſtein.*
   - *a.* Reddiſh brown garnet, found in the mine called Granat-Skierpningen, at Nya Kopparberg, in the province of Weſtmanland.
   - *b.* Whitiſh yellow, from Torrakeberget, in the pariſh of Gorborn, in Wermeland.
   - *c.* Pale yellow, from Sikſioberget, and Veſterſilfverberget, in Kopparbergſlan, in Sweden.
2. Cryſtalliſed garnet, *Granatus cryſtalliſatus.*
   - *a.* Black, from Swappawari, in Lapland.
   - *b.* Red, ſemi-tranſparent, and cracked, from Engſo, at the Lac Malaren, in Weſtmanland.

     Tranſparent, *Granatus gemma.*
   - *c.* Reddiſh yellow tranſparent, the jacinth, or hyacinth, *Hyacintus gemma*, from Greenland, and Bergen's Stift in Norway.

     I am not certain whether the oriental jacinth and that from Siberia are of the ſame kind; but this garnet from Greenland is by the jewellers ſold as a jacinth.
   - *d.* Reddiſh brown, from Kallmora and Stripas, at Norbery, in Weſtmanland.
   - *e.* Green, from Eibenſtock in Saxony, and Gellebeck, in Norway.
   - *f.* Yellowiſh green, from Gellebeck.

SECT. LXX.

B. Garnet mixed with iron and tin, *Granatus crocis Martis et Jovis mixtus.*

1. Coarſe grained, without any particular figure, *Granatus particulis granulatis figura indeterminata.*
   a. Blackiſh brown, from Moren, at Weſtanfors, in Weſtmanland.
2. Cryſtalliſed.
   a. Blackiſh brown, from Moren.
   b. Light green or white, from Gokum, at Dannemora, in the province of Upland.

   The Bergs-radets, or mine-maſters, Mr. Brandt and Mr. Rinman have publiſhed ſome experiments on this kind of garnet, in the Memoirs of the Royal Academy of Sciences at Stockholm.

SECT. LXXI.

C. Garnet mixed with iron and lead, *Granatus calcibus Martis et Saturni mixtus.*

1. Cryſtalliſed.
   a. A reddiſh brown, from Arſet, in the pariſh of Froderyd, in the province of Smoland.

   This was diſcovered, and accurately examined by the Bergs-radet Mr. Von Swab*.

* When any of the garnet kind is to be tried for its containing metal, the iron ought to be melted out of it by the common proceſs; and if the garnet, at the ſame time, contains both tin and lead, theſe two metals are likewiſe included in the iron: however, they may be extracted out of the iron, by

SECT. LXXII.

2. Cockle or Shirl, *Baſaltes*; *Corneus cryſtalliſatus Wallerii*; *Stannum cryſtallis columnaribus nigris Linnæi*.

Is a heavy and hard kind of ſtone, which ſhoots into cryſtals of a priſmatical figure, and whoſe chief colours are black or green. Its ſpecific gravity is the ſame as the garnets, viz. between 3000 and 3400, though always proportionable to their different ſolidity.

A. Cockle, or ſhirl, mixed with iron, *Baſaltes martialis*.

1. Coarſe, without any determined figure, *Baſaltes particulis palpabilibus figura indeterminata*.

a. Green, found in moſt of the Swediſh iron mines.

by expoſing it to a heat augmented by degrees, becauſe then the tin and lead ſweat out in form of drops, almoſt pure, though always ſomewhat mixed with iron.

The criſtalliſations of the garnets are ſo far different from one another, that ſome have a greater and ſome a leſs number of facets, or ſides; but this has no relation or dependence either on their contained metals, their colour, or their tranſparency; wherefore, in order to avoid a prolixity, which is unneceſſary, I have omitted ſuch varieties, and only obſerved that they are round or ſpherical, with facets. Beſides, there is not yet diſcovered any figure amongſt them which is abſolutely particular and remarkable, for the *granatus dodecaedros ex rhombis Linnæi* are diſperſed every where in the rocks at Kongsberg, in Norway.

SECT.

SECT. LXXIII.

2. Sparry, *Basaltes spatosus.*
   - *a.* Deep green, (the mother of the emeralds) from Egypt *.
   - *b.* Pale green, from Westersilfverberget, and Hagge, at Norberke, Linbastmoren, at Grangierde, in the province of Westmanland, &c.
   - *c.* White, from Silf-udden, at Westersilfverberget, Pargas in Finland, the lime-rocks at Lillkyrkie, in the province of Nerike, &c.

   This occurs very frequently in the scaly lime-stones, and its colour changes from deep green to white, in proportion as it contains more or less of iron.

SECT. LXXIV.

3. Fibrous, *Basaltes particulis fibrosis*; Striated cockle, or shirl: it looks like fibres, or threads made of glass.
   - *A.* Of parallel fibres, *Basaltes fibris parallelis.*
     - *a.* Black, from Gustavsberg, in the province of Jemtland, the island Uto, in the Lake Malaren, &c.
     - *b.* Green, in most of the Swedish iron mines.
     - *c.* White, from Westersilfverberget, in the province of Westmanland, Lillkyrkie in Nerike, and Pargas in Finland.

* The Plasma, or mother of the emerald of authors, is a fine pellucid true quartz, of a green or emerald colour, not a stone of this kind. D. C.

B. Of concentrated fibres, *Basaltes fibris concentratis*; The ſtarred cockle, or ſhirl, from its fibres being laid ſtellarwiſe.

a. Blackiſh green, from Salberg, in Weſtmanland, where, being found together with a ſteel grained lead ore, the whole is called, *gran-ris-malm*, or pine-ore, from its reſemblance to the branches of that tree. This kind of cockle is alſo found at Uto, in Malaren.

b. Light green, from Kerrbo, at Skinſkatteberg, in Weſtmanland.

c. White, at Lillkyrkie in Nerike, Weſterſilfverberget in Weſtmanland, and Pargas in Finland.

SECT. LXXV.

4. Cryſtalliſed cockle, or ſhirl, *Baſaltes cryſtalliſatus.*

a. Black, from France, Yxſio at Nya Kopparberg, in the province of Weſtmanland, Umea in Lapland, Oſterbottn in Sweden.

* To this ſpecies of cockle, or ſhirl, belong moſt of thoſe ſubſtances called *imperfect aſbeſti*; and as the cockle perfectly reſembles a ſlag from an iron furnace, both in regard to its metallic contents, and its glaſſy texture, it is no wonder that it is not ſoft enough to be taken for an aſbeſtus. It has however, only for the ſake of its ſtructure, been ranked among the aſbeſti; and it is ſurpriſing, that the fibrous gypſum, from Andrarum, in the province of Skone, has eſcaped being on the ſame account confounded with them. The ſtriated cockle, or ſhirl, compared to the aſbeſti, is of a ſhining and angular ſurface (though this ſometimes requires the aid of the magnifying-glaſs to be diſcovered) always ſomewhat tranſparent, and is pretty eaſily brought to a glaſs with the blow-pipe, without being conſumed, as the pure aſbeſti ſeem to be. (See Aſbeſti, Sect. cii.)

b. Deep

b. Deep green, from Salberg in Weſtmanland.

c. Light green, from Enighets-grufvan at Norberg, in Weſtmanland,

d. Reddiſh brown, from Sorwik, at Grengie in Weſtmanland, and Glanſhammar, in the province of Nerike.

The Tauffstein, from Baſil, is of this colour, and conſiſts of two hexagonal criſtals of cockle grown together in form of a croſs: this the Roman Catholics wear as an amulet, and is called in Latin, *lapis crucifer*, or the croſs-ſtone * †.

* It is not impoſſible, that there may be ſome kinds of cockles, or ſhirls, which, beſides iron, alſo contain tin or lead, as the garnets: but I am not quite convinced of it; though I have been told, that lead has been melted out of a cockle, from Rodbeck's Eng, at Umea, in Lapland; and it ſeems likewiſe very probable, that the cockles which are found in the Engliſh tin mines, may contain ſome tin. There are ſome criſtals of cockle found, which are fuſible to a greater degree than any ſort of ſtone whatſoever: theſe are always of a glaſſy texture, and ſemi-tranſparent.

The figure of the cockle criſtals is uncertain, but always priſmatical: the cockle from Yxſio, at Nya Kopparberg, is quadrangular; the French kind has nine ſides, or planes, and the Tauffſtein is hexagonal ‖.

† The croſs-ſtone is compoſed of two claſſes, for the baſis I make a fluor, (See my Lectures) and the croſſes on it I agree with our author are accretions of ſhirl, or cockle. He denominates it, the *Baſler Tauffstein*. Whether he means by Baſler the city of Baſil, as I have put it, or whether he means Beſler, the author who firſt deſcribed it, I cannot tell; but certainly it is not found at or near Baſil, being, as far as I know, a local foſſil, namely, of St. John de Compoſtella, in Andaluſia in Spain. D. C.

‖ The name Cockle for theſe ſubſtances is an old Corniſh mineral name; but is alſo given ſometimes to other very different matters. The name Shirl I have now adopted in Engliſh, from the common German mineral term.

We have not in England any great quantity of ſpecies of cockles; the chief are found in the tin mines of Cornwall, and I have ſeen ſome fine criſtalliſed kinds from Scotland.

SECT. LXXVI.

Observation on the Garnet Kind.

When this kind contains ſo much of iron as renders it profitable to be worked, it is conſidered as a good iron ore, and no notice is taken of its natural character, in the ſame manner as is done with clays and jaſpers that contain iron: for the richneſs of metal in theſe riſes in a gradual progreſſion, until they acquire the colour and appearance of the iron itſelf.

Thus a kind of garnet is melted in a furnace, not far from Eibenſtock, in Saxony, and the ſame ſpecies is found, and might alſo be employed at Moren, in Weſtmanland. Jaſpers are for this purpoſe melted in Hungary, and clays in England; but as the greateſt part of the garnet kind contains ſo little iron as to yield only between ſix and twelve per cent. which is too poor to be worked any where in the world as a profitable iron ore, the reſt and the greateſt part of it being a mere earth, it muſt in a natural hiſtory be conſidered and ranked among the earths.

The tin grains ſhould have got a place in this order, 1. If I had known any of them to contain tin in ſo ſmall a portion as five per cent. as this quantity of tin is the moſt that ever can be obtained from the garnets; 2. If it was proved that a calx of iron always was mixed with it, as in the garnet; and, 3. If I did not believe that the

The Engliſh mineral name of *Call*, has been uſed by ſome authors as ſynonymous with cockles, and is even confounded together at the mines; but the Call, definitely ſpeaking, is the ſubſtance called Wolfram by the Germans, &c.

Garnets, though ſmall, are often found in micaceous ſtones in England; but extreme good garnets are found in great plenty alſo in like ſtones in Scotland. D. C.

tin

tin calx might by itſelf take a ſpherical polygonal figure, at its induration, as well as the garnet. The white tin grains, (Sect. ccx.) out of which no tin, but only iron, is to be got, might with more reaſon be placed here, if it was not ſo exceſſively refractory in the fire, and if it did not, at laſt, melted either by itſelf, or with borax, give a clear and colourleſs glaſs, contrary to what the garnet does, which difference ariſes from the different fuſibility of theſe two ſubſtances.

The garnet and cockle are not yet known to me in form of an earth or clay, taken in the common idea we have of thoſe bodies. It is true, that there is a bole found at Swappawari, in Lapland, which has the ſame figure as the garnet; and the hornblende, (Sect. lxxxviii.) which is ſomewhat harder than this bole, has often the appearance of a cockle. We cannot, however, do more than problematically ſuppoſe them to be the neareſt related to the garnet kind, as we have not yet diſcovered a method how to ſeparate earths from the contained metals, without deſtroying their natural form, and eſpecially from iron, when it is ſo ſtrongly united with them, as if it had a part in their formation itſelf.

SECT. LXXVII.

The Fourth Order.

The Argillaceous Kind, *Argillaceæ*.

The principal character whereby theſe may be diſtinguiſhed from other earths, is, that they harden in the fire, and are compounded of very minute particles, by which they receive a dead or dull appearance when broken.

Moreover, there are ſome of this order which grow ſoft in water, and, when only moiſtened, become ductile and tenacious: theſe are commonly called clays. Some crack in the water, after having imbibed a ſufficient quantity of it, but do not grow ſofter in it, and are therefore in the firſt degree of induration: ſome imbibe the water, but do not crack or fall to pieces; theſe are yet more indurated: and finally, ſome there are, in which the water has no ingreſs at all. Thus, by following the ſucceſſive gradation of induration of a ſubſtance, which throughout all theſe circumſtances is eaſily diſcovered to be the ſame, one may with great reaſon conclude, that the hardneſs of the jaſper may perhaps be the laſt degree of hardneſs, and that this ſtone conſequently conſiſts of an argillaceous ſubſtance, (Sect. lxv.) that already poſſeſſes a quality which the other clays cannot acquire but in the fire; having, beſides, the ſame effect as the boles (Sect. lxxxvi.) when melted in the fire together with calcareous or other earths.

SECT. LXXVIII.

A. Porcellain Clay, *Terra Porcellanea*, vulgò *Argilla Apyra*.

Is very refractory in the fire, and cannot in any common ſtrong fire be brought into fuſion any farther than to acquire a tenacious ſoftneſs, without loſing its form: it becomes then of a dim ſhining appearance and ſolid texture, when it is broke; ſtrikes fire with ſteel; and has conſequently the beſt qualities required, as a ſubſtance whereof veſſels capable of reſiſting a melting

ing and boiling heat, and of holding ſalts and acids, can be made. It is found,

1. Pure, *Pura.*

A. Diffuſible in water.

1. Coherent and dry.

a. White, from Japan.

I have ſeen a root of a tree changed into this clay. (Appendix, Section cclxxxiii.)

2. Friable and dry.

a. White, is found in clefts of rocks at Weſterſilfverberget in Weſtmanland, and between the coal, in the coal-pits at Boſerup, in the province of Skone *.

2. Mixed with phlogiſton, and a very ſmall quantity of inſeparable heterogeneous ſubſtances, *Terra porcellanea phlogiſto aliiſque heterogeneis minimâ portione mixta.* Of theſe are,

A. Diffuſible in water,

a. White and fat pipe clay, from Cologne and Maeſtricht.

Leſs unctuous is found in ſmall fiſſures in a vein of *lapis ollaris*, at Swartwik, in the pariſh of Swerdſio, in the province of Dalarne.

b. Of a pearl colour, from Maeſtricht.

c. Bluiſh grey, *La belle terre glaiſe* from Montmartre, near Paris, in France.

d. Grey, France, Heſſe, Boſempin, Skone.

* Theſe may be called pure, ſince after being burnt, they are quite white, though they have been expoſed to a quick melting heat; and it may be queried, if all ſuch clays muſt not be ſomewhat harſh, or at leaſt not unctuous to the touch.

e. Black, *La terre noire*, at Montmartre.
f. Violet, alſo from Montmartre *.

SECT. LXXIX.

B. Indurated, *Indurata.*

Is commonly unctuous to the touch, and more or leſs difficult to be cut or turned, in proportion to its different degrees of hardneſs; is not diffuſible in water, grows hard, and is very refractory in the fire; pounded and mixed with water, it will not eaſily cohere in a paſte: however, if it is managed with care, it may be baked in the fire to a maſs, which, being broke, ſhews a dull and po-

* Theſe contain a phlogiſton, which is diſcovered by expoſing them to a quick and ſtrong fire, in which they become quite black interiorly, aſſuming the appearance of the common flints, not only in regard to colour, but alſo in regard to hardneſs: but if heated by degrees, they are firſt white, and afterwards of a pearl colour. The fatter they ſeem to be, which may be judged both by their feeling ſmooth and unctuous, and by their ſhining, when ſcraped with the nail, they contain a larger quantity of the inflammable principle. It is difficult to determine, whether this ſtrongly adherent phlogiſton is the cauſe of the above-mentioned pearl colour, or prevents them from being burnt white in a ſtrong fire: yet no heterogeneous ſubſtance can be extracted from them, except ſand, which may be ſeparated from ſome, by means of water, but which ſand does not make out any of the conſtituent parts of the clays. If they be boiled in aqua regis, in order to extract any iron, they are found to loſe their viſcoſity. In the leſs unctuous clays, I have found pure quartz in greater and ſmaller grains; but ſtill I would not venture to aſſert, that one is produced from the other, according to the rule I have laid down in Sect. ix. 1. I have likewiſe found this ſort, upon certain occaſions, attract the phlogiſton in the fire. Theſe remarks may ſerve as hints for the leſs experienced, who have a mind to examine thoſe clays, which are of ſo great conſequence for their œconomical uſes.

rous

rous texture. It takes for the moſt part, and without much labour, a fine poliſh. It is found,

1. Compact and ſoft, *Particulis impalpabilibus mollis*; Smectis, Briançon, or French chalk.
   a. White, from the Lands End, in Cornwall.
   b. Yellow.
   c. Red and white, Land's End: the Soap Earth, Switzerland. It looks like Caſtile ſoap.

SECT. LXXX.

2. Solid and compact, *Particulis impalpabilibus ſolida*; Steatites, and alſo Soap-Rock.
   a. White, or light green, from Riſver, in Norway, Bareuth, and Sikſioberget, at Norberke, in Weſtmanland.
   b. Deep green, from Salberg, in Weſtmanland, Swartwik, in Dalarne, Jonuſwando, in Lapland, Salviſto, at Tamela, in Finland, &c.
   c. Yellow, from Juthyllen, at Salberg, Torrakeberget, at Goſborn, in the province of Vermeland, and China*.

* It is a very difficult matter to ſpecify all the varieties of the ſoap-ſtones, in regard to their hardneſs or ſoftneſs, ſince they cannot be compared with any ſtandard meaſure. Thoſe from Riſver, Sikſioberg, and China, are a great deal harder and more ſolid than the Engliſh kind, from the Land's End, which breaks between the fingers; but are ſoft in compariſon to that from Salberg, which is there called *Serpentine*, although both theſe varieties may indiſcriminately be made uſe of for cutting and turning. The ſoft ones, however, are not ſo apt to crack, when they are worked, as the harder. But

SECT. LXXXI.

3. Solid, and of viſible particles, *Solida particulis majoribus*; Serpentine ſtone, *Lapis Serpentinus.*

1. Of fibrous and coherent particles, *Lapis ſerpentinus fibroſus.*

This is compoſed, as it were, of fibres, and might therefore be confounded with the aſbeſtus, if its fibres did not cohere ſo cloſely with one another, as not to be ſeen when the ſtone is cut and poliſhed. The fibres themſelves are large, and ſeem as if they were twiſted.

a. Deep green.

Is ſold for the *lapis nephriticus*, and is dug at ſome unknown place in Germany.

b. Light green, from Skienſhyttan, in Weſtmanland; is uſed by the plate-ſmiths, inſtead of the French chalk.

SECT. LXXXII.

2. Fine grained Serpentine ſtone, *Serpentinus particulis granulatis*: the Zoeblitz Serpentine.

But none of theſe varieties is found in the rock, without being interſperſed with the unctuous clefts. When they are too many, too cloſe to one another, and make the ſtone unfit for uſe, they are in this caſe called by the Swediſh miners, *Skiolige*; and of this kind is a great quantity found at Salberg and Swartwik. Moſt part of the ſoap-rock, which is found in Sweden, is likewiſe mixed with glimmer or mica, and then it is called *Telgſten*, that is, *Ollaris*, Sect. cclxv.

a. Black.

a. Black.
b. Deep green.
c. Light green.
d. Red.
e. Bluiſh grey.
f. White. Theſe colours are all mixed together in the ſerpentine ſtone, from Zoeblitz, but the green is the moſt predominant colour.

SECT. LXXXIII.

3. Mixed with iron, *Terra porcellanea marte mixta*. This is

A. Diffuſible in water.

a. Red, *la terre rouge*, from Montmartre, and China.

Some of the bricks which are imported from ſome certain places in Germany, ſeem to be made of this kind.

B. Indurated.

1. Martial ſoap earth, *Creta Brianzonica martialis*.

a. Red, from Jarſberg, in Norway.

It is likewiſe mixed with ſome calcareous matter.

2. Martial ſoap rock, *Steatites martialis*.

a. Black, from Sundborn, in Dalarne, Torrakeberget, in Wermeland, Offerdal, in Jemtland.

b. Red, from Siljejord in Telemarken, in Norway *.

* Since the iron renders the ſo called refractory clays, as well as other clays, eaſier fuſible than they really are by themſelves; it might be queried, how it can be determined, of what ſpecies of argillaceous matter theſe conſiſt? To this it

SECT. LXXXIV.

B. Stone Marrow, *Lithomarga*: *Keffekil* of the Tartars.

I have given this name to a kind of clay, which,

1. When dry, is as fat and ſlippery as ſoap: but,
2. Is not wholly diffuſible in water, in which it only falls to pieces, either in larger bits, or reſembles a curd-like maſs.
3. In the fire it eaſily melts to a white or reddiſh frothy ſlag, therefore conſequently is of a larger volume than the clay was before being fuſed.
4. It breaks into irregular ſcaly pieces.

A. Of coarſe particles: Coarſe Stone Marrow.

a. Grey, from Oſmundſberget, in the pariſh of Rettwik, in Dalarne, and is there called *walklera*, that is, fuller's earth. It is mentioned in an account of Oſmundſberget, publiſhed in the Tranſactions of the Academy of Sciences at Stockholm, in the year 1739, by the Berg's-radet, or mine-maſter, Mr Tilas.

b. Whitiſh yellow, from the Crim Tartary, where it is called Keffekil,

it is anſwered, That they are found together in the ſame beds with the porcelain clay: that they have all the ſame external ſigns, and differ from it only in the colour, being red, brown, or black, in regard to the contained metal: that they are more refractory in the fire than any other martial clay; and that, though they may be reduced ſo as to reſemble a black or iron-coloured ſlag, they yet retain their form.

and

and is ſaid to be uſed for waſhing inſtead of ſoap.

B. Of very fine particles: Fine Stone Marrow.

a. Yellowiſh brown, *Terra Lemnia.*

Is of a ſhining texture, falls to pieces in the water with a crackling noiſe; it is more indurated than the precedent, but has otherwiſe the ſame qualities *.

SECT. LXXXV.

C. Bole, *Bolus.*

Is a fine and denſe clay of various colours, containing a great quantity of iron, which makes it impoſſible to know the natural and ſpecifical qualities of the bole itſelf, by any eaſy method hitherto in uſe. It is not eaſily ſoftened in water, contrary to what the porcelain and the common clays are (*A.* & *E.*), but either falls to pieces in form of ſmall grains, or repels the water, and cannot be made ductile. In the fire it grows black, and is then attracted by the load-ſtone.

* This cannot properly be called a *fuller's earth*, ſince it neither is of that kind uſed in the fulling buſineſs, nor is likely to be applicable to it ‡. It is, beſides, a very ſcarce clay. It is not found indurated, ſo far as I know; and if it ſhould at any time be diſcovered, it will be neceſſary to examine, if it is not a Zeolites (or the eighth order), or at leaſt very nearly approaching to it, in regard to the effects both undergo in the fire.

‡ As the beſt ſort of Fuller's Earth did not come into our author's hands, it is no wonder that he excludes it from its due place. The true Fuller's Earth of England is exactly like the ſtone marrow in all the above-mentioned properties; and in regard to the texture and colour, it comes neareſt to the above-deſcribed coarſe ſtone marrow. E.

SECT. LXXXVI.

1. Loose and friable boles, or those which fall to a powder in water.
   - *a.* Flesh-coloured bole, from Kristiersberg, at Nya Kopparberg, in Westmanland.
   - *b.* Red.
     1. Fine, *Bolus Armenus.*
     2. Coarse, *Bolus communis officinalis*, from the sand-stone quarries at Orsa, in the province of Dalarne.
     3. Hard, *Terra rubrica.*
   - *c.* Green, *Terre verte.*
     1. Fine, from Italy.
     2. Coarse, from Stenstorp, in the province of Westergottland.
   - *d.* Bluish grey, from Stollberget, in Kopparbergslan, in Sweden.

     Is ductile as long as it is in the rock, but even then repels the water; it contains forty per cent. of iron; which metal being melted out of it in a close vessel, the iron crystallises on its surface.
   - *e.* Grey.
     1. Crystallised in a spherical polygonal figure: from Swappawari, in Lapland.
     2. Of an undetermined figure, from Grengerberget, in Westmanland *.

‡ At the time when the *terræ sigillatæ*, or sealed earths, were in general use, the druggists endeavoured to have them of all colours; and for that reason they took all sorts of clays and sealed them; not alone the natural ones, but likewise such as had been coloured by art, or had been mixed with *magnesia alba officinalis*, or other things, were afterwards vended for true boles; and for this reason the species of boles

SECT. LXXXVII.

2. Indurated Bole, *Bolus indurata.*

A. Of no viſible particles, *Particulis impalpabilibus.*

This occurs very often in form of ſlate, or layers in the earth, and then is made uſe of as an iron ore. However, it has uſually been conſidered more in regard to its texture, than to its conſtituent parts, and has been called ſlate, in common with ſeveral other earths, which are found to have the ſame texture.

a. Reddiſh brown, from England †.

b. Grey, from Coalbrookdale, in Shropſhire, and moſt collieries of England.

SECT. LXXXVIII.

B. Of ſcaly particles, *Particulis ſquamoſis:* The hornblende of the Swedes.

boles is ſtill thought to comprehend ſo many varieties. Thus the Cologne clay (Sect. lxxviii.) is by the druggiſts ranked among the white ſealed earths, and is called a *white bole:* and this ſame clay is by the Swediſh potters called *Englesk jord*, or Engliſh earth; and by the tobacco-pipe makers, *Pip-lera*, or pipe clay, &c. which ſhews how great a confuſion there muſt enſue, if the knowledge of theſe bodies was not founded upon a ſurer ground than the colour, figure, and names invented by common mechanics. Since the moſt part of theſe *terræ ſigillatæ*, or ſealed earths, are found to contain iron, I conclude, that the bole muſt be a martial clay; and, as ſuch, it ſeems to be more fit for medical uſes than other clays, if any dead earth muſt be uſed internally, when there is ſuch an abundance of finer ſubſtances.

† In moſt collieries between the ſeams of coal, as at Hannam, in Kingſwood, near Briſtol, Blanavon, in Monmouthſhire, &c. D. C.

Is diſtinguiſhed from the martial glimmer, or mica, (Sect. xcv.) by the ſcales being leſs ſhining, thicker, and rectangular.

a. Black. This, when rubbed fine, gives a green powder.

b. Greeniſh.

Both theſe, particularly the black, are found every where in Sweden among the iron ores, and in the Grunſten (Section cclxix *).

SECT. LXXXIX.

D. Tripoli, *Terra Tripolitana.*

Is known by its quality of rubbing hard bodies, and making their ſurfaces to ſhine, the particles of the tripoli being ſo fine, as to leave even no ſcratches on the ſurface. This effect, which is called poliſhing, may likewiſe be effected by other fine clays, when they have been burnt a little. The tripoli grows ſomewhat harder in the fire, and is very refractory : it is with difficulty diſſolved by borax, and ſtill with greater difficulty by the microcoſmic ſalt : it becomes white when it is heated : when crude, it imbibes water, but is not diffuſible in it : it taſtes like common chalk, and is rough or ſandy between the teeth, although no ſand can by any means be ſeparated from it. It has no quality common

* The hornblende grows hard in the fire, which is the reaſon why it is ranked here among the clays, though in all its other qualities it much reſembles the cockle or ſhirl. (Section lxxii.) E.

with

with any other kind of earth, by which it might be conſidered as a variety of any other. That which is here deſcribed, is of a yellow colour, and is ſold by druggiſts, who do not know where it is found *.

SECT. XC.

Æ. Common Clay, or Brick-Clay, *Argilla communis; vulgaris Plaſtica.*

This kind may be diſtinguiſhed from the other clays, by the following qualities.

1. In the fire it acquires a red colour, more or leſs deep.
2. It melts pretty eaſily into a greeniſh glaſs.
3. It contains a ſmall quantity of iron and of the vitriolic acid, by which the preceding effects are produced.

It is found,

A. Diffuſible in water.

1. Pure.

a. Red clay, from Kinnekulle, in the province of Weſtergottland.

b. Fleſh coloured, or pale red, is found on the plains between Weſteras and Sala, in the province of Weſtmanland.

c. Grey, in the corn-fields in the province of Upland.

* I have got of this kind of tripoli from Scotland, which has been lately diſcovered there. But the rotten-ſtone, ſo called, is another ſort found in England, viz. in Derbyſhire. It is in common uſe here in England among workmen for all ſorts of finer grinding and poliſhing, and is alſo ſometimes uſed by lapidaries for cutting of ſtones, &c. D. C.

d. Blue, is very common in Sweden, in the provinces bordering upon the Baltic.

e. White, is found in the woody parts of Sodermanland, Dalarne, and of other provinces. It is often found in a slaty form, with fine sand between its strata. It is not easy to be baked in the fire: when it is burnt, it is of a pale red colour, and is more fusible than the preceding ones.

f. Fermenting clay, *Argilla intumescens.*

This is very like the preceding (*e*), as to the external appearance, and other qualities; but when they are both found in the same place, which is not uncommon in several of our mine countries, they seem to be different in regard to the fermenting quality of this variety. This fermentation cannot be the effect of the sand mixed with it, because sand is found in them both: and besides, this kind ferments in the same manner when it is mixed with gravel or stones; and then it ferments later in the spring than the other, since by the stones, perhaps, the frost is longer retained in it.

2. Mixed with lime, see Marle, Section XXV.

SECT.

SECT. XCI.

B. Indurated.

1. Pure.
   a. Grey ſlaty.
   b. Red ſlaty, from Kinnekulle, in the province of Weſtergottland.
2. Mixed with phlogiſton, and a great deal of the vitriolic acid. See Alum Ores, Sect. cxxiv.
3. Mixed with lime. See Lime, Sect. xxviii *.

* It is probable, although it is not eaſily demonſtrable, that the common clay, and eſpecially the blue, grey, and pale red, which are the ſoils of our plains and dales bordering upon lakes, has its origin from mud, and that the mud owes its exiſtence to vegetables; conſequently that theſe varieties of clay are nothing elſe than a mould, or *humus ater*, ſomewhat altered by means of water, and by length of time. The following circumſtances contribute greatly to confirm this opinion, viz. that a great quantity of ſea-plants rot every year in the lakes, and are changed into mud; that very little, however, of this mud is ſeen upon the ſhores after the water is dried in ſummer-time; and that the clay begins where the mud ceaſes. Concerning the turf, or peat, it is to be obſerved, that this is not always produced from vegetables growing upon the very ſame ſpot where it is cut, but from ſuch vegetables as have been thrown together from other places: for in what other manner could hazle-nuts occur in the turf-moors, in places where no hazle-trees grow, even at a diſtance of many miles? not to mention other inſtances of the ſame nature. Secondly, the turf, or peat, is cut in humid and low marſhes, which are not conſtantly covered with water, as on the banks of lakes over-grown with graſs. If the origin of turf was any other than here mentioned, there ought to be turf found inſtead of mud at the bottom of lakes where there is plenty of graſs.

The quantity of iron, and of the vitriolic acid contained in this clay, would perhaps not be found greater than to anſwer in proportion to the quantity of each of theſe ſubſtances, that enters into the compoſition of vegetables, whilſt growing, if there were any poſſibility of making the compariſon. Mean

SECT. XCII.

OBSERVATION on CLAYS in general.

Thofe who have taken upon themfelves to examine the mineral bodies according to the principles upon which this Syftem is built, will readily, I hope, excufe thofe faults which may have been committed in claffing the clays; becaufe they muft well know, not only how difficult it is to procure a number of different varieties of this order in their natural ftate, which have not been previoufly wafhed or prepared for

while I have in dry fummers obferved on the fea-fhore, that a perfect iron vitriol has been growing out of the mud, clays, and vegetables not yet rotted, which has been thrown up there together.

When this opinion is once proved to be true, one may venture to go farther, and endeavour by obfervations and experiments to prove likewife, that in the fubverfions or changes that the earth has more than once fuffered in every part of it, and in which water has contributed the moft to carry off the particles, and to change the ftrata, the clay has been gathered together, and lodged in beds together with other fubftances. Some of thefe ftrata have afterwards been indurated, by which means they are turned into the above flaty and limy clays; and when they have been mixed with a great quantity of vegetables, and of the inflammable fubftance, they may in length of time be changed into pit-coal: but when they have been mixed with lefs phlogifton, and a great quantity of the vitriolic acid, they conftitute the alum ores, &c.

Others of thofe ftrata, which are not yet hardened, prove ftill, by their being fet or divided with fome feparating veins of fand, that they have been formed in the fame manner as the fettlings or fediments of ftamping mills, and may perhaps, through edulcoration in water, or through age, have loft their fertility, fince they never are fo good to improve lands with, as thofe ftrata which are fuppofed to be of a more recent formation, fuch as *b, c, d.*

ufe,

uſe, as the ſealed earths, &c. but alſo that it is no eaſy matter diſtinctly to deſcribe ſome little circumſtances that occur to the eye, both in their natural ſtate, and during the experiments. Beſides, they cannot but remember, that the progreſſional degrees both of hardneſs, and of the quantity of mixed heterogeneous bodies, eſpecially iron, produce a number of imperceptible differences between them, in regard to colour and effects; ſo that they cannot with due preciſion be ſeparated and divided into their true genera, ſpecies, and varieties, before ſome more evident differences between them may, by repeated experiments, and perhaps by proceſſes yet unknown, be diſcovered. In examining the clays, one ought carefully to obſerve the different degrees of fire due to each kind: for without this knowledge they can never be employed to any real uſe in common life. Next to this, there is another point equally neceſſary to be taken notice of, that is, the manner of working the clays, which is often different in different kinds, and which, not leſs than the different degrees of fire, is productive of different effects; and therefore, if both theſe circumſtances are not at the ſame time exactly deſcribed, it is as wrong to aſſert with ſome authors, that a refractory clay does never crack in the fire, as it is deceiving to pretend that the ſame clay does never imbibe the water, when it has been baked. Hence comes that great difference in regard both to appearances and qualities, between a tobacco-pipe, which is very little baked, and a jar from Waldenburg, between a common brick and the other ſort called a water clinkert.

The uſe of clays, in common life, is more extenſive than I have been able to inform myſelf of; for which reaſon I will only mention ſome particulars relating to it.

The porcelane clay is employed to make veſſels which have that quality already mentioned (Sect. lxxviii.). I make no doubt but it enters into the compoſition for making the fine porcelane ware at ſome places; at leaſt veſſels are prepared from it of the ſame goodneſs in every reſpect: and there are likewiſe ſome varieties of this clay, which become quite white in the fire, a quality which is eſteemed the moſt valuable in the fine China ware.

The indurated porcelane clay cannot be eaſily heated without cracking, and is therefore of no great ſervice, if hardened in the fire alone, and in its natural ſtate: though this circumſtance is of leſs inconveniency, than when it has original cracks, or is mixed with heterogeneous ſubſtances. The ſteatites * is found purer and more ſolid in China than in any place in Europe. The natural faults of the European ones may, however, be altered by adding ſome fat ſubſtance to it, when it is to be burnt; by which means it becomes black or brown; and this method is ſaid to be uſed at Bareith. The coarſe porcelane-like earth, which goes by the name of *French clay*, is uſed at the glaſs-houſes, ſteel furnaces, and other works of the ſame nature, for the ſame reaſons as it is the

* The ſteatites here meant is the ſubſtance of which the Chineſe joſſes or figures commonly called rice figures are made: it is, according to my method, of the claſs of Talcs, and of the genus of Nephritics. D. C.

principal

principal ingredient in the making of crucibles, retorts, &c.

The boles have almoſt loſt their value as medicines, and are employed to make bricks, potters-ware, and pig-iron.

The tripoli is an indiſpenſible article for the poliſhing of metals, and ſome ſorts of ſtones; it is likewiſe on certain occaſions preferred for making moulds to caſt metals in.

The common clay is of the greateſt benefit in agriculture, except however the white clay and the fermenting clay, both of Sect. xc. which varieties we know not yet how to apply to any uſe. By virtue of its coherency, this clay retains humidity, on which perhaps its chief benefit to vegetables depends, its other effects being occaſional, owing either to nature or art; unleſs the clay has formerly been a mould or *humus ater*, in which caſe it is juſt, that part of it ſhould enter again into the formation of the new vegetables. The clay uſed in the refining of ſugar, wants no other quality than that it may not dry too ſoon. But that ſpecies which is to be employed in fulling, muſt, if we were to judge *à priori*, beſides the fineneſs of its particles, be of a dry nature, or ſuch as attracts oils; though this quality may perhaps not be found in all thoſe clays which are now employed in that buſineſs.

SECT. XCIII.

The FIFTH ORDER.

The Micaceous Kind, *Micaceæ*. The Glimmer, Daze, or Gliſt.

These are known by the following characters.

1. Their texture and composition consist of thin flexible particles, divisible into plates or leaves, having a shining surface.
2. These leaves, or scales, exposed to the fire, lose their flexibility, and become brittle, and then separate into thinner leaves: but in a quick and strong fire, they curl or crumple, which is a mark of fusion; though it is very difficult to reduce them into a pure glass by themselves, or without addition.
3. They melt pretty easily with borax, the microcosmic salt, and the alcaline salt; and may, by means of the blow-pipe, be brought to a clear glass, with the two former salts. The martial mica is, however, more fusible than the uncoloured ones.

There is not yet discovered any loose earth of this kind, but it is always found indurated.

SECT. XCIV.

A. Colourless or pure mica; Daze, Glimmer, or Glist; *Mica alba, sive pura.*

1. Of large parallel plates, *Mica constans lamellis magnis parallelis.* Muscovy glass, *Vitrum Muscoviticum.*

   Is transparent as glass; found in Siberia, and Elfdalen in the province of Wermeland.

2. Of small plates, *Mica squamosa,* from Silfverberget, at Runneby, in the province of Blekinge.

3. Of

3. Of particles like chaff, or chaffy mica, *Particulis acerosis.*
4. Of twisted plates, crumpled mica, *Mica contorta, Talcum officinale.*

SECT. XCV.

B. Coloured and martial glimmer, *Mica colorata martialis.*

1. Of large parallel plates, *Mica lamellosa martialis.*
   - *a.* Brown semi-transparent, from Kola, in Lapland.
2. Of fine and minute scales.
   - *a.* Brown.
   - *b.* Deep green, from the mine of Salberg, in the province of Westmanland.
   - *c.* Light green, *Talcum officinale*, found in the ollaris, from Handol, in the province of Jemtland.
   - *d.* Black, found in the granites, in the province of Upland.
3. Twisted or crumpled glimmer, *Mica contorta martialis.*
   - *a.* Light green, in the ollaris, from Handol.
4. Chaffy glimmer, *Mica martialis particulis acerosis.*
   - *a.* Black, is found in the stone called *hornberg*, which occurs in most of the Swedish copper-mines; for instance, those at Norberg, Flodberg, &c.
5. Cristallised glimmer, *Mica drusica.*
   1. Of concentrated and erect scales, *Drusa micacea constans squamis concentratis perpendicularibus caryophylloides.*

2. Of

2. Of hexagonal horizontal plates, *Drusa micacea constans squamis hexagonis horizontalibus.* This is found in the mines at Salberg, in the province of Westmanland.

SECT. XCVI.

OBSERVATION on the MICÆ, or GLIMMERS.

The stones belonging to this order are by most authors considered as Apyri, which they really are in some degrees of heat, and when they are mixed with certain bodies: but they may at the same time with equal propriety be called Vitrescents, both *per se* or by themselves, because they melt with that degree of fire in which neither quartz nor limestone are in the least altered; and are still more readily fused, when mixed with a martial earth, either by nature or art: hence, if *hornberg* is naturally mixed with copper ores, as is frequently found in Sweden, it is no way detrimental to the smelling of them, as they commonly contain a sufficient quantity of sulphureous acid, which scorifies the iron. But when the glimmer is mixed with quartz, it may perhaps be impossible to melt it, because it renders the quartz so compact, as to prevent it from cracking, which may be seen on the rock-stone (Sect. cclxii.): The mica does the same, when it is interspersed in an apyrus clay; and this is the reason why the ollaris so strongly resists the fire.

The mica has in some degree the same qualities as an argillaceous earth; but, for want of sufficient experiments and observations, we cannot yet assert it to be a product of clay.

The

The martial mica in a calcining heat acquires a yellow ſhining colour, which has induced many to examine it for gold; but nothing can be obtained from it except iron, which may be diſſolved or extracted by means of aqua regis: although a late German author has pretended that he produced from the mica an unknown ſemi-metal, which reſembled iron mixed with zink. Nevertheleſs he owns, that he has not examined this ſemi-metal, and that for obtaining it he uſed a flux, compoſed of ſeveral metals, ſome of which probably united with the iron in the mica: wherefore it is probable we ſhall never hear more of it.

Some of the micaceous kind ſeem fat and unctuous, and others harſh and dry: it is not improbable that the former may contain a phlogiſton, although this cannot be extracted from them in form of a pure *oleum talci*; in other particulars, they are ſo like one another, that there is no reaſon for making them two diſtinct genera.

The *talc cubes*, as they are called, which have the figure of alum, and are ſometimes found in the copper-mine of Falun, in the province of Dalarne, and which are very much valued by ſome foſſilogiſts, are, when broke, found to conſiſt of an iron ore, often mixed with a yellow or marchaſitical copper ore, and only covered with a very thin coat of mica.

The tranſparent Muſcovy glaſs is uſed for windows, and upon all occaſions where panes of glaſs are wanted. Perhaps it might alſo be advantageouſly employed to cover houſes.

The twiſted or crumpled mica, which is found at Handol in Jemtland, is there manufactured into kettles and other veſſels, as alſo for hearths of chimnies; and the powder which falls in the working

working of this ſtone may be mixed with the common ſalt, for the diſtillation of the muriatic acid.

SECT. XCVII.

The SIXTH ORDER.

The Fluors *, *Fluores Minerales*. Suet. *Fluſſ-arter*. Germ. *Fluſſ-arten*.

Theſe are commonly called fluxing vitreſcent, or glaſs ſpars, becauſe moſt part of them have a ſparry form and appearance: they are, however, often met with in an indeterminate figure.

Theſe are only known in an indurated ſtate, and diſtinguiſh themſelves from the other earths, by the following characters.

1. They are ſcarce harder than a calcareous ſpar, and conſequently do not ſtrike fire with the ſteel.
2. They do not ferment with acids, neither before nor after calcination, notwithſtanding a phlogiſton or an alcali had been added in the calcination.
3. They do not melt by themſelves, but only ſplit to pieces when expoſed to a ſtrong fire †. But,
4. In mixtures with all other earths, they are very fuſible, and eſpecially when they are

* I have adopted the name of Fluors, in Engliſh, to this order. D. C.

† There may, perhaps, be ſome fluors that are pretty refractory in the fire, ſo as not to be melted: however, all thoſe which I have tried, have melted pretty eaſily by the blow-pipe; but I have always taken great care in theſe experiments, that they might not fly away before they were heated through. E.

blended

blended with the calcareous earth, with which they melt to a corroding glaſs, which diſſolves the ſtrongeſt crucibles, unleſs ſome quartz or apyrus clay is added thereto.

5. When heated ſlowly, and by degrees, they give a phoſphoreſcent light: but as ſoon as they are made red-hot, they loſe this quality. The coloured ones, and eſpecially the green, give the ſtrongeſt light, but none of them any longer than whilſt they are well warm.

6. They melt and diſſolve very eaſily by the addition of borax, and next to that by the microcoſmic ſalt, without ebullition.

SECT. XCVIII.

A. Indurated Fluor, *Fluor mineralis induratus.*

1. Solid, of an indeterminate figure, *Fluor particulis impalpabilibus, figurâ indeterminatâ.*

Is of a dull texture, ſemi-tranſparent, and full of cracks in the rock.

a. White, found in Batgrufvan, at Yxſio in Nya Kopparberget in Weſtmanland.

SECT. XCIX.

2. Sparry Fluor, *Fluor Spatoſus.*

It has nearly the figure of ſpar, though, on cloſe obſervation, it is found not to be ſo regular, nothing but the gloſſy ſurfaces of this ſtone giving it the reſemblance of ſpar.

a. White,

a. White, found in Stripas at Norberg, in the province of Westmanland.
b. Blue, from Norrgrufve, at Westersilfverberget in Westmanland.
c. Violet, from Diupgrufvan, at the last mentioned place, and also from Stripas and Fogerlid; and Gislof in the province of Skone.
d. Deep green, from Stollberget in Stora Kopparbergslan.
e. Pale green, from Kuppgrufven, at Garpenberg in the province of Dalarne.
f. Yellow, from Gislof in Skone.

SECT. C.

3. Crystallised Fluor, *Fluor crystallisatus*, when in single cristals; but Fluor Druse, when many cristals are heaped together.
   1. Of an irregular figure.
      a. White.
      b. Blue, both from Norberget and Norberg in Westmanland.
      c. Red, from Heslekulla iron-mine, in the province of Nerike.
   2. Of a cubical figure.
      a. Yellow, and
      b. Violet, from Gislof in Skone, Blyhall in the parish of Barkaro in the province of Westmanland.
   3. Of a polygonal spherical figure.
      a. White, from Bockbackeveggen in Falun copper-mine in Dalarne.
      b. Blue, from Bondgrufvan, at Norberg in Westmanland.

4. Of

4. Of an octoëdral figure.
   a. Clear, colourleſs. This I have ſeen in the collection of the mine-maſter Mr. Von Swab.

SECT. CI.

Observation on the Fluors.

There are not yet any probable reaſons given, why theſe ſtones ſhould be ranked amongſt the calcareous or any other earths; and if I am not quite miſtaken in my judgment, they are ſo much the more different from the calcareous earth, as they, when melted together with it, produce an effect which never can be aſcribed to the alcaline earths; not to mention, that there is by no method yet known any calcareous ſubſtance to be extracted from them, nor is there any poſſibility of decompounding them.

That which cauſes the phoſphoreſcent light vaniſhes in the fire, it being impoſſible to collect it: in the preſent ignorance of the nature of this matter, it cannot therefore be aſſerted, whether it is one of the conſtituent parts neceſſary to the compoſition of theſe ſtones, or if, in regard to its ſmall quantity, it even deſerves any attention. I take it to be a ſubtle phlogiſton, which being modified in various manners, gives riſe to ſuch various colours.

At mineral works this kind of ſtone is very uſeful in promoting the fuſion of the ores, and is therefore as much valued by the ſmelters, as the borax is by the eſſayers: it has alſo from this quality got the name of *fluor*, or *flux*.

The reſemblance between the coloured fluors, and the compoſitions made of glaſs, has perhaps contributed

contributed not only to the fluors being reckoned of the same value as the coloured quartz crystals, by such collectors as only mind colour and figure; but also to their obtaining a rank among the precious stones in the apothecaries and druggists shops. They, however, may be permitted to enjoy that honour, since our modern physicians do not make more use of them than of the others.

SECT. CII.

The Seventh Order.

The Asbestus Kind, *Asbestinæ*.

These are only yet discovered in an indurated state: their characters are as follow.

1. When pure, they are very refractory in the fire.
2. In large pieces they are flexible.
3. They have dull or uneven surfaces.
4. In the fire they become more brittle.
5. They do not strike fire with the steel.
6. They are not attacked by acids.
7. They are easily brought into fusion by borax.

In this order are included both those varieties which by fossilogists have been mentioned under the names of *Amianti* and *Asbesti*, and have often been confounded together.

SECT. CIII.

1. Asbestus which is compounded of soft and thin membranes, *Asbestus membranaceus*; *Amiantus Wallerii.*

A. Of parallel membranes, *Asbestus membranis constans parallelis: Corium,* sive *Caro Montana,* Mountain-leather.

1. Pure.
   a. White, from Salberg in Westmanland.
2. Martial.
   a. Yellowish brown, from Storrginningen, at Dannemora, in the province of Upland.

   This melts pretty easily in the fire to a black slag, or glass.

SECT. CIV.

B. Of twisted soft membranes, *Asbestus membranis constans contortis: Suber montanum,* Mountain cork.

1. Pure.
   a. White, from Salberg in Westmanland.
2. Martial.
   a. Yellowish brown, from Dannemora. This has the same quality in the fire as the martial mountain leather.

SECT. CV.

2. Of fine and flexible fibres, *Asbestus fibrosus: Asbestus,* or Earth Flax, *Asbestus Wallerii.*

A. With parallel fibres, *Aſbeſtus fibris conſtans parallelis: Byſſus.*

1. Pure and ſoft.
   a. Light green, from Schelkowa Gora in Siberia.
   b. White, from Ulrica's Ort in the mine of Salberg in Weſtmanland: it is there found together with mountain leather.
2. A little martial, and more brittle.
   a. Greeniſh, from Baſtnas Grufva, at Ryddarhyttan in Weſtmanland. There it forms the greateſt part of the vein out of which the copper ore is dug; a great part of it is conſequently melted together with the ore, and is then brought to a pure ſemi-tranſparent martial ſlag or glaſs.

SECT. CVI.

B. Of broken and recombined fibres, *Aſbeſtus fibris conſtans abruptis et conglutinatis.*

1. Martial.
   a. Light green, from Baſtnas Grufva at Riddarhyttan.

SECT. CVII.

It has been already obſerved under the title of Cockle, or Shirl, (Sect. lxxiv.) that the aſbeſtus is often confounded with it.

Observation on the Asbestus Kind.

I am much inclined to believe that the Aſbeſti, as well as the Micæ, are produced from an argillaceous

gillaceous earth, both becauſe they become brittle in the fire, which is a proof that they harden, and becauſe they become more fuſible by the admixtion of a martial earth: but the method nature makes uſe of for this change is as unknown, as it might perhaps in other reſpects be neceſſary, not to force the earths together, for ſome ſlight reaſon, within the compaſs of a few orders.

The Siberian Aſbeſtus, which may be conſidered as the principal and chief of the fibrous kind, is, as it were, conſumed by the flame of a blow-pipe, and does not leave any more certain mark of fuſion; but it melts readily with borax to a clear and colourleſs glaſs.

The natural ſtore of this kind is in proportion to its œconomical uſe, both being very inconſiderable. It is an old tradition, that in former ages they made cloaths of the fibrous aſbeſti, which is ſaid to be expreſſed by the word *Byſſus*; but it is not very probable, ſince, if one may conclude from ſome trifles now-a-days made of it, as bags, ribbons, and other things, ſuch a dreſs could neither have an agreeable appearance, nor be of any conveniency or advantage. It is more probable that the Scythians dreſſed their dead bodies, which were to be burnt, in a cloth manufactured of this ſtone; and this has perhaps occaſioned the above fable.

Paper is likewiſe made from this ſtone, only to ſhew its fixity in the fire, and to procure ſome eſteem and value to this curious ſubſtance.

It was reported ſome years ago, that the French ſearched for aſbeſti, in order to mix it with the tar for preſerving houſes and ſhips; but the queſtion is, If the aſbeſti can be of more ſervice than pounded mica, or charcoal-duſt employed to the ſame purpoſe?

SECT. CVIII.

The Eighth Order.

Zeolites.

This is defcribed in its indurated ftate, in the Tranfactions of the Academy of Sciences at Stockholm, for the year 1756, and there methodifed as a ftone *fui generis*, in regard to the following qualities.

1. It is a little harder than the fluors, and the calcareous kind: it receives however fcratches from the fteel, but does not ftrike fire with it.
2. It melts eafily by itfelf in the fire, with a like ebullition as borax does, into a white frothy flag, which not without great difficulty can be brought to a folidity and tranfparency.
3. It is eafier diffolved in the fire by the mineral alcali (*fal fodæ*), than by the borax and microcofmic falt.
4. It does not ferment with this laft falt, as the lime does; nor with the borax, as thofe of the gypfeous kind.
5. It diffolves very flowly, and without any effervefcence, in acids, as in oil of vitriol and fpirit of nitre. If concentrated oil of vitriol is poured on pounded zeolites, a heat arifes, and the powder unites into a mafs *.

* Since the publication of this Effay, there has been difcovered more varieties of the zeolites, particularly at Adelfors's gold-mines in Smoland in Sweden, of which fome forts do not melt by themfelves in the fire, but diffolve readily in the acid of nitre, and are turned by it into a firm jelly. E.

6. In

6. In the very moment of fuſion it gives a phoſphorus or light.

SECT. CIX.

The zeolites is found in an indurated ſtate.

1. Solid, or of no viſible particles, *Zeolites ſolidus particulis impalpabilibus.*
   - *A.* Pure, *Zeolites durus.*
     - *a.* White, from Iceland.
   - *B.* Mixed with ſilver and iron.
     - *a.* Blue, *Lapis lazuli*, from the Buckarian Calmucks.

       This, by experiments made with it, has diſcovered the following properties.

       1. It retains for a long time its blue in a calcining heat, but is at laſt changed into a brown colour.
       2. It melts eaſily in the fire to a white frothy ſlag; which, when expoſed to the flame of a blow-pipe, is greatly puffed up, but in a covered veſſel, and with a ſtronger heat, becomes clear and ſolid, with blue clouds in it.
       3. It does not ferment with acids: but,
       4. Boiled in the oil of vitriol, it diſſolves ſlowly, and loſes its blue colour.

          When a fixed alcali is added to this ſolution, a white earth is precipitated, which being ſcorified with borax, yields a ſilver regulus, that varies in bigneſs, according to the various ſamples of the ſtone.

5. By ſcorification with lead, there has been extracted two ounces of ſilver out of a hundred pounds weight of the ſtone.

6. The preſence of ſilver is not diſcovered with the ſame certainty by the ſpirit of nitre as by the oil of vitriol.

7. When the ſpirit of ſal ammoniac is added to any ſolution, made either of crude, or of a perfectly calcined lapis lazuli, there is no blue colour produced; which proves that this colour is not owing to copper, as ſome have pretended: and this is farther confirmed by the fixity of the blue colour in the fire (1, 2.), and by the colour of the ſlag or glaſs (2.).

8. It is a little harder than the other kinds of zeolites, but does not however in hardneſs approach to the quartz, or to other ſtones of the ſiliceous kind in general; becauſe the pureſt and fineſt blue lapis lazuli may be rubbed with the ſteel to a white powder, although it takes a poliſh like marble.

9. The lapis lazuli, when perfectly calcined, is a little attracted by the loadſtone; and ſcorified with lead, the ſlag becomes of a greeniſh colour, not ſuch a colour as copper gives, but ſuch as is always produced by iron mixed with a calcareous ſubſtance *.

* The lapis lazuli is ſeldom found pure, but is moſt generally full of veins of quartz, limeſtone, and marcaſite: however,

SECT. CX.

2. Sparry Zeolites, *Zeolites ſpatoſus.*

This reſembles a calcareous ſpar, though it is of a more irregular figure, and is more brittle.

a. Light red, or orange-coloured, from Nya Krongrufvan, one of the gold-mines at Adelfors, in the province of Smoland.

ever, for theſe experiments none but the pureſt pieces have been picked, ſuch as have been examined through a magnifying-glaſs, and been judged as free from heterogeneous mixtures as poſſible. It is to be wiſhed, that thoſe who have a ſufficient quantity of this ſtone would continue theſe experiments, in order to diſcover what ſubſtance it is that makes this blue colour, which is ſo conſtant in the fire, ſince it cannot depend either on copper or iron; for though thoſe metals, on certain occaſions, give a blue colour, yet they never produce any other but what inſtantly vaniſhes in the fire, and is deſtroyed by means of an alcali. What is mentioned in ſeveral books about the preparation of the ultramarine from ſilver, can by no means be objected here, ſince in thoſe proceſſes the ſilver employed is mixed with copper, and other ſubſtances, which contain a volatile alcali, whereby the blue colour is produced ‡.

In regard to the above-mentioned qualities of this ſtone, it cannot be claſſed under any other kind of earth than this.

‡ Mr. Margraf has ſince, in his Chemical Diſſertations, printed in German in the year 1761, publiſhed ſome experiments on the lapis lazuli; and in the chief agrees with our author, without, however, knowing any thing of theſe his experiments. Mr. Margraf alſo proves that there is no copper in this ſtone; and beſides tells us, that he has found both a calcareous and a gypſeous ſubſtance in it, although he took care to pick out only the very pure bits for his experiments However, I am led to imagine, that the calcareous ſubſtance is not eſſential to the exiſtence of the lapis lazuli, ſince Mr. Cronſtedt expreſly ſays, that the ſtone he tried did not ferment at all with acids. He farther mentions this remarkable circumſtance, which makes it ſtill more evident that the lapis lazuli belongs to the zeolites, viz. that, when calcined and diſſolved in the acids of vitriol, of common ſalt, and of nitre, it turned all thoſe acids into a jelly. However, he does not take any notice of its containing any ſilver, becauſe he did not proſecute his experiments ſo far on that point; but ſome of his experiments, nevertheleſs, ſeem to indicate, as if all ſorts of lapis lazuli did not contain ſilver. E.

SECT. CXI.

3. Criſtalliſed Zeolites, *Zeolites cryſtalliſatus.*

Is more common than the two preceding kinds, and is found,

A. In groupes of criſtals in form of balls, and with concentrical points, *Cryſtalli zeolitis pyramidales concreti ad centrum tendentes.*

a. Yellow, from Swappawari, in Tornea in Lapland.

b. White, from Guſtavſgrufvan, in the province of Jemtland.

B. Priſmatical and truncated criſtals, *Cryſtalli zeolitis diſtincti figura priſmatica truncata.*

a. White, from Guſtavſgrufvan in Jemtland.

C. Capillary criſtals, *Cryſtalli zeolitis capillares.*

Are partly united in groupes, and partly ſeparate. In this latter accretion they reſemble the capillary, or feather ſilver ore (Sect. clxxiii.), and is, perhaps, ſometimes called *Flos ferri*, at places where the nature of that kind of ſtone is not yet fully known.

Theſe criſtals are found,

a. White, from Guſtavſgrufvan in Jemtland.

SECT. CXII.

Observation on the Zeolites.

This kind of ſtone has nearly the ſame qualities in the fire as the boles (Sect. lxxxv); ſo that both of of them, when more nicely examined, may perhaps be found to belong to the ſame order, and perhaps be ſome kind of earth, whoſe properties have been long and perfectly known.

The *terra porcellanea Luneburgica*, which Bruckman mentions, and Mr. Wallerius has ranked among the gypſa, may, perhaps, belong to this order: but I have not been able to procure a ſpecimen of it, to compare it with the zeolites, which alſo is very ſcarce, not being found in our country except in very ſmall veins and cavities. To this ſcarcity is owing, that it has not yet been tried in the fire together with other kinds, except with the ſparry fluor. With that it does not fuſe very readily, becauſe, when equal parts of them are melted together, an opaque ſlag or glaſs is produced of the ſame colour with the alcali of nitre, of a fibrous texture, and of an uneven ſurface.

The quality of ſwelling in the fire, like the borax, is peculiar to the criſtals, (Sect. cxi.) becauſe the other varieties riſe only into ſome ſmall bliſters, which are of a white colour at their edges, and inſtantly cover themſelves with a white glaſſy ſkin, after which they become quite refractory.

SECT. CXIII.

The Ninth Order.

The Manganeſe Kind, *Magneſiæ*.

The ſtones belonging to this order, are in Swediſh called *Brunſten*, in Latin *Sydereæ*, or *Magneſiæ nigræ*, in order to diſtinguiſh them from the *Magneſia alba officinalis*, and in French *Mangoneſe*, &c. They are by ſome litho-

lithographifts entirely omitted, and by others ranked among the iron ores; but, as I am convinced both by my own experience, and by that of others, that they contain no greater quantity of metal than fometimes two or three per cent. of iron, and fometimes a little tin, I think that the remaining part, which muft confequently be confidered as a kind of earth, deferves its particular feparate place in a mineral fyftem, at leaft until a farther infight into its nature may be obtained: and to this opinion I have been perfuaded by its following peculiar qualities:

1. The manganefes confift of a fubftance, which gives a colour both to flags, and to the folutions of falts, or, which is the fame thing, both to dry and to liquid menftrua; viz.
   a. Borax, which has diffolved manganefe in the fire, becomes tranfparent, of a reddifh brown or jacinth colour.
   b. The microcofmic falt becomes tranfparent with it, of a crimfon colour, and moulders in the air.
   c. With the fixed alcali, in compofitions of glafs, it becomes violet; but if a great quantity of manganefe is added, the glafs is in thick lumps, and looks black.
   d. Scorified with lead, the glafs gets a reddifh brown colour.
   e. The lixivium of a deflagrated manganefe is of a deep red colour.
2. It deflagrates with nitre, which is a proof that it contains fome phlogifton.
3. When reckoned to be light, it weighs as much as an iron ore of the fame texture.
4. Being melted together with glafs compofitions, it ferments during the folution: but it

it ferments in a ſtill greater degree, when it is melted with the microcoſmic ſalt.

5. It does not excite any efferveſcence with the ſpirit of nitre: aqua regia, however, extracts the colour out of the black, and diſſolves likewiſe a great deal of it, which, by means of an alcali, is precipitated to a white powder.

6. Such colours as are communicated to glaſſes by manganeſe, are eaſily deſtroyed by the calx of arſenic or tin: they alſo vaniſh of themſelves in the fire.

7. It is commonly of a looſe texture, ſo as to colour the fingers like ſoot, although it is of a metallic appearance when broke.

SECT. CXIV.

Manganeſe is found,

A. Looſe and friable, *Magneſia friabilis terriformis.*

a. Black, ſeems to be weathered or decayed particles of the indurated kind, from England.

SECT. CXV.

B. Indurated, *Magneſia indurata.*

1. Pure, in form of balls, whoſe texture conſiſts of concentric fibres, *Magneſia pura ſphærica radiis concentratis.*

a. White, *Magneſia alba ſtrictè ſic dicta,* is very ſcarce. I have ſeen a ſpecimen of this kind in a collection from an unknown place in Norway; and by examining a piece of it, I found that it differed from the

the common manganese, by giving to the borax a deep red colour in the fire: this sort acquires a reddish brown colour when it is calcined.

b. Red manganese is said to be found in Piedmont. This I have never seen; but I have been told by an ingenious gentleman, that this variety is free from iron, and gives to glass rather a red than a violet colour.

SECT. CXVI.

2. Mixed with a small quantity of iron, *Magnesia parum martialis*.

a. Black manganese, with a metallic brightness. This is the most common kind, and is employed at the glass-houses, and by the potters.

It is found,

1. Solid, of a flaggy texture, *Magnesia textura vitrea*, from Skidberget, in the parish of Leksand, in the province of Dalarne.
2. Steel grained, also from Skidberget.
3. Radiated, *Radiata*, still from Skidberget, and Tiveden, in the province of Ostergottland.
4. Cristallised.

a. In form of coherent hemispheres, *Hemispheriis continuis*, from Skidberget in Leksand.

SECT. CXVII.

3. Blended with a small quantity of iron and tin, *Magnesia parva cum portione martis*

tis et jovis mixta: Spuma Lupi, or *Wolfram* *.

1. With coarſe fibres.

a. Of an iron colour, from Altenberg in Saxony. This gives to the glaſs compoſitions, and alſo to borax and the microcoſmic ſalt, an opaque whitiſh yellow colour, which at laſt vaniſhes.

SECT. CXVIII.

OBSERVATIONS on the MANGANESE.

Though it may ſeem difficult to many, to diſtinguiſh the kinds of manganeſe by their appearance, or external marks; yet it is extremely eaſy to know them by experiments made in the fire, if attention is had to the above-mentioned phenomena (Sect. cxiii.). From hence it is not difficult to comprehend why manganeſe has hitherto been either omitted, or erroneouſly ranked in ſyſtems, viz. becauſe it has, like many other mineral bodies, been examined only by ſight, while the more troubleſome method of examining it in the fire, has been overlooked.

Some might perhaps imagine the manganeſe to be the remainder of ſome metal, which cannot be reduced again into its metallic ſtate; but it ought to be remembered, that no metal can, by any means yet known, be brought to an abſolutely irreducible earth or calx, unleſs perhaps by the burning-glaſs, and therefore there is no reaſon to ſuſpect that nature gives ſuch a production. Ig-

* Wolfram is a name which is alſo ſometimes given to mock lead, and ſometimes to cockle, or ſhirl, as alſo to other minerals; however, it is chiefly given to this ſpecies of manganeſe, when it occurs in the tin-mines. E. and D. C.

norance

norance and idleneſs have invented certain terms or expreſſions, to avoid giving an account of thoſe ores or mineraliſations, which are not eaſy enough to be decompounded; for inſtance, *wild*, *rapacious*, *arſenical*, *volatile*, &c. and ſome iron ores in particular have been thus called; by which means it has happened, that œconomical reflections have often been added to natural and philoſophical deſcriptions: and thus others are deterred from examining many bodies, of which we have got, and ſtill retain falſe notions by this way of proceeding.

The manganeſe has by ſyſtematiſts been commonly ranked among ſuch iron ores; but the artificers who make uſe of it in the manufacture of glaſs do not know it; nor can they by any means be perſuaded to uſe any of the pretended bodies a-kin to it, inſtead of the manganeſe itſelf, ſince experience prevails more with them than ſuppoſitions. The conſumption of the manganeſe is but ſmall, and therefore it is not a very profitable article.

SECT. CXIX.

The SECOND CLASS.

The SALTS, *Salia*.

By this name thoſe mineral bodies are called, which can be diſſolved in water, and give it a taſte; and which have the power, at leaſt when they are mixed with one another, to form new bodies of a ſolid and angular ſhape, when the water in which they are diſſolved is diminiſhed to a leſs quantity than is required to keep them

them in ſolution; which quality is called Criſtalliſation *.

SECT. CXX.

In regard to the known principal circumſtances or qualities of the mineral ſalts, they are divided into

1. Acid Salts, or Mineral Acids, *Salia Acida.*
2. Alcaline Salts, or Mineral Alcalis, *Salia Alcalina.*

The First Order.

Acid Salts, *Salia Acida.*

The characters of theſe ſalts are, that they,

1. Have a ſour taſte.
2. Are corroſive; that is to ſay, have a power of diſſolving a great number of bodies.

* No other ſalts ought to be conſidered and ranked in a mineral ſyſtem, but thoſe which are found natural in the earth (Sect. i.); and for this reaſon a great number of ſalts will be in vain looked for here, viz. all ſuch as are either natural or prepared by art in the other two kingdoms of nature, and from ſubſtances belonging to them. Amongſt theſe is nitre itſelf, and its acid, and the vegetable acid, ſince theſe are never had from true mineral bodies; nor is it demonſtrated, that they have their origin from the true mineral vitriolic and muriatic acids. There have, indeed, been many attempts made to reduce moſt of them to a vitriolic acid, which by many is called the univerſal acid: but experiments will not agree with it; at leaſt nobody has yet been able, by uniting a phlogiſton with another acid than the true vitriolic, to produce any ſubſtance in every particular reſembling the true brimſtone, or ſulphur. For this reaſon I cannot yet give my aſſent to Doctor Pietſch's opinion, who endeavours to prove, that the acid of nitre is derived from the vitriolic acid, that is, before his theory is confirmed by experience in the large way, and the analyſis has been more plainly laid open: but I think the

3. They have a ſtrong attraction to the alcaline ſalts and earths, whence they always unite with them with an effervefcence, and ſometimes with a ſtrong heat: by this mixture bodies are produced, which are employed in common life under the names of *vitriols*, *neutral ſalts*, *gypſum*, &c.
4. They change moſt of the expreſſed blue juices of vegetables into red.

the queſtion remains ſtill undecided, if the nitrous, vegetable, and urinous acids are primitive ſubſtances? or if they owe their origin to one and the ſame principle? and, if this laſt be the caſe, of what nature this principle is? But howſoever this may prove, the conſideration of theſe acids ſeems more properly to belong to another ſcience. The ſame may be ſaid of the doctrine which holds, that the nitre is produced from the principles of the ſea-ſalt, by a certain peculiar modification.

The above-mentioned two mineral acids, whoſe qualities we know nothing of, until they have been by art extracted from the vitriols, and the ſea-ſalt, are indeed never found pure in nature, becauſe as ſoon as they, on any occaſion, are, either by a natural or artificial heat, ſeparated from any ſubſtance, they inſtantly attack and unite with another. Neverthelefs, as they may, and perhaps ſometimes really do exiſt in form of vapours, which eſcape our ſight; and that the theory of the ſalts, and the ſaline ores, is founded upon qualities already diſcovered in theſe acids; I have thought it neceſſary to deſcribe them ſuch as they are, when mixed with pure water alone; and this the rather, ſince the water is their moſt common vehicle, in the exerciſe of their effects in the mineral kingdom.

It has been obſerved before (Sect. xi.), that the qualities of arſenic in form of a calx may agree with the definition of the ſalts, and at the ſame time be reckoned among the ſemimetals, which cannot be any otherwiſe explained, than that the arſenic conſidered in a certain reſpect and form, is a ſalt; and when conſidered in other circumſtances, a metal. This is the caſe with ſeveral other bodies of the mineral kingdom.

5. They

5. They ſeparate the alcali from the fat, when they have been united in ſoap; which effect is called to *curdle*, or coagulate.
6. They are volatile and ſubtile, ſo as never to be obſervable by the naked eye, unleſs they are mixed with heterogeneous bodies; and therefore the figure of the pure mineral acids cannot be defined but by gueſs.

SECT. CXXI.

A. The vitriolic acid, *Acidum vitrioli aluminis et ſulphuris.*

I. The pure vitriolic acid, *Acidum vitrioli purum.*

Is, in abſtract, conſidered as poſſible to occur in nature: its qualities, when mixed with water, in which it is caught by diſtillation, are as follows.

1. When mixed with the leaſt poſſible quantity of water, it is of an unctuous appearance, and is for that reaſon improperly called oil of vitriol.
2. It has in that ſtate a conſiderable heavineſs, viz. in compariſon to water, as 1700 to 1000.
3. It diſſolves ſilver, tin, the regulus of antimony, and quickſilver; but,
4. When mixed with more water, it diſſolves zinc, iron, and copper.
5. It diſſolves likewiſe the calcareous earth, and precipitates with it in form of a gypſum, of which a part ſhoots into gypſeous Druſen, *Selenites et cryſtalli gypſei.*
6. It unites with the earth of quartz, when it has been previouſly diſſolved in the

liquor ſilicum; and with a pure argillaceous earth, diſſolving it without any fermentation: with both theſe earths it makes alum.

7. It has a ſtronger attraction to the inflammable ſubſtance, than to the alcaline ſalt, and forms with it a body, which properly may be called the *mineral ſulphur*.

8. When it is perfectly united with phlogiſtic ſubſtances belonging to the vegetable kingdom, and the water has been perfectly ſeparated, this mixture catches flame in the open air, and is conſumed, as may be ſeen by the powder called *Pulvis pyrophorus*.

9. It attracts water ſtrongly, and the aqueous vapours out of the air: and if a great quantity of water is added to it at once, a ſtrong heat ariſes.

10. It unites readily and eaſily with the alcalis, whereby, according to their nature, different compounds are produced, which have obtained the names of *Tartarus vitriolatus*, *ſal mirabile*, and *ſal ammoniacum fixum*.

SECT. CXXII.

. The vitriolic acid mixed or ſaturated, *Acidum vitrioli aliis corporibus ſaturatum.*

A. With metals, *Metallis ſaturatum. Vitriola*, Vitriols.

a. Simple vitriols, *Vitriola ſimplicia.*

1. Martial vitriol, green vitriol or copperas, *Vitriolum martis ſimplex.*

This

This is the common green vitriol, which naturally is found dissolved in water, and is produced in abundance by decayed or calcined marcasites.

2. Copper vitriol, blue vitriol, *Vitriolum Veneris seu Cypricum.*

This is of a deep blue colour, and is found in all Ziment waters, as they are called; for instance, at Neusohl in Hungary, in St. Johan's mine at Fahlun in the province of Dalarne, at Nya Kopparberget in Westmanland, and the copper-mines at Wicklow in Ireland, &c. It is however seldom perfectly free from an admixture of iron and zink.

3. Zink vitriol, *Vitriolum zinci.*

Is white and clear as alum, and is found at the Rammelsberg in the Hartz, as also in the rubbish at Stollgrufvan in Westmanland, where the mock lead has decayed either spontaneously, or after having been burnt.

SECT. CXXIII.

b. Compound vitriols, *Vitriola composita.*

1. Vitriol of iron and copper, *Vitriolum ferrum et cuprum continens.*

Is of a bluish green colour.

2. Vitriol of iron, zinc, and copper, *Vitriolum ferrum zincum et cuprum continens.*

 This

This verges more to the blue than to the green colour. It is made at Fahlun in Dalarne, from the water which is pumped out of the copper-mines: in this water large criſtals of vitriol are often ready formed. If this vitriol is dipped in water, and afterwards rubbed on clean iron, the copper does not precipitate from it.

3. Vitriol of zinc and iron, *Vitriolum zinco-ferreum.* This is the green vitriol from Goſlar in the Hartz.

4. Vitriol of zinc and copper, *Vitriolum cupreo zinceum.* This is the blue vitriol from Goſlar.

5. Vitriol of nickel and iron, *Vitriolum ferrum et niccolum continens.*

Is of a deep green colour, and is contained in the ochre or decayed parts of the Nickell, at the Cobalt-mines at Los, in the province of Helſingland*.

* Moſt part of the vitriols owe their formation to art: becauſe when ſuch ores as contain ſulphur, are dug out of the mines by means of fire, the phlogiſton of the ſulphur is by the heat expelled, leaving the acid behind, which, being let looſe or freed, is thereby enabled to attract and unite with watry vapours, diſſolving at the ſame time the metals; and it is thus the vitriols are formed. Every ſort of ore does not commonly decay or weather in a natural manner, without being promoted by art; and this decaying or weathering is moſtly performed in the open air; for which reaſon no very great quantity of vitriol can be expected in that way: for when any ore thus weathers or decays, the diſſolved particles are by degrees carried off by the rain, and are at laſt found in a diſſolved ſtate in certain ſprings or mineral waters. All ſuch ores may therefore be called true vitriol ores, as contain iron, copper, zinc, and nickel mineraliſed with ſulphur. The acid in the vitriols, however, is not dulcified by the metals, as it is by the alcali in the true neutral ſalts.

SECT. CXXIV.

B. The acid of vitriol mixed or ſaturated with earths, *Acidum vitrioli terris mixtum ſeu ſaturatum.*

1. With a calcareous earth. Gypſum. See Sect. xiii.

2. With an argillaceous earth. The Alum kind, *Alumina.*

a. With a ſmall quantity of clay, *Acidum vitrioli argillâ ſaturatum.* Native or plumoſe alum, *Alumen nativum ſive plumoſum.*

Is found on decayed alum ores in very ſmall quantities; and therefore through ignorance the alabaſtrites and ſelenites, both of which are found among moſt of the alum ſlates, are often ſubſtituted in its ſtead; as is alſo ſometimes the aſbeſtus, notwithſtanding the great difference there is between the alum and theſe, both in regard to their uſes and effects *.

b. With a greater quantity of pure clay, *Argilla pura acido vitrioli imbuta.* White alum ore, *Minera aluminis alba.*

* The gypſa and aſbeſti, but more eſpecially the latter, have been uſed through ignorance, in moſt countries, for plumoſe native alum; and the ſort ſold formerly in the ſhops for it was a greeniſh white kind, from Germany, very rigid, but extremely brittle, and breaking into ſpicula or prickles. Selenites was never ſubſtituted for alum; and the reaſon the aſbeſti and fibroſe gypſa were ſubſtituted for it, was only on account of the ſimilarity of ſtructure, not, as our author ſays, on account of their being found together. See my Lectures. D. C.

1. Indurated pale red alum ore, *Schistus aluminis Romanus.* Is employed at Lumini, not far from Civita Vecchia in Italy, to make the pale red alum called Roach Alum. This is, of all alum ores, the most free from iron; and the reddish earth which can be precipitated from it, does not shew the least marks of any metallic substance.

c. With a very large quantity of martial clay, which likewise contains an inflammable substance, *Argilla martialis et phlogistica acido vitrioli imbuta.* Common alum ore.

Is commonly indurated and slaty, and is therefore generally called Alum Slate, *Schistus aluminosus ater et brunescens.*

It is found,

1. Of parallel plates, with a dull surface, *Schistus lamellosus regularis,* from Andrarum in the province of Skone, Hunneberg and Billingen in the province of Westergottland, Rodoen in the province of Jemtland, and the island of Oeland, &c.*

2. Undulated and wedge-like, with a shining surface, *Schistus aluminosus undulatus et cuneiformis fissuris splendentibus.*

This at the first sight resembles pit coal; it is found in great abundance in the parish of Nas in Jemtland †.

* In England, the great alum works at Whitby, in Yorkshire, are of this kind. D. C.

† The purity above-mentioned (*b.* 1.) of the earth of the Roman or roach alum, is meant with the same restriction as

SECT. CXXV.

C. Vitriolic acid united with phlogiston, *Acidum vitrioli phlogisto combinatum.* The sulphur kind, *Sulphura.* See Sect. cli.

SECT. CXXVI.

D. Vitriolic acid saturated with alcaline salt, *Acidum vitrioli alcali minerali saturatum.*

as in general is understood by that expression, viz. that the heterogeneous particles are not very obvious, nor of any great consequence.

The phlogiston which is contained in the black alum slates, may perhaps during the calcination dispose the iron to be easier dissolved; and it may also occasion the black colour in some of them, that even contain but very little of iron, as most likely in part of those from Nas (*c.* 2.).

It is not easily determined, whether the earth in the alum slates is argillaceous or quartzose, or whether it is a black indurated *humus*, or mould, because all those three earths, when dissolved in the vitriolic acid, produce alum. The Cologne pipe-clay is a plain proof of the first; the quartzose earth, in *liquor silicum*, of the second; and aluminous fossil-woods are actually employed for making alum in Bohemia and Hesse. These earths may, or may not, contain iron; however, they prevent, in the former case, the phlogiston, together with the vitriolic acid, from mineralizing all the iron, and making a marcasite of it, excepting here and there, in some insignificant quantity, as in cracks, or when it meets with some heterogeneous bodies, as shells, insects, &c. in the said earths. There is a remarkable progression from the black alum slates to the pit-coal, in proportion as the quantity of the phlogiston encreases, and the quantity of the earth decreases (Sect. clix.). It is this phlogiston which makes this alum slate capable of burning by itself, when it is once lighted; wherein it differs from the alum ores of Lumini, which, in order to be brought to moulder, require the being exposed to the heat of the sun, and to be sprinkled with water: the former has also within itself sufficient matter to spontaneously flame upon certain occasions, according to what the *a*. With the alcali of the common ſalt, or ſea-ſalt, *Alcali minerali ſaturatum : Sal mirabile Glauberi.*

This is a neutral ſalt, prepared by nature, as well as by art, containing more or leſs of iron, or of a calcareous earth, from which ariſes alſo ſome difference in its effects, when internally uſed. It ſhoots eaſily into priſmatical criſtals, which become larger in proportion to the quantity of water evaporated before the criſtalliſation. When laid on a piece of burning charcoal, or elſe burnt with a phlogiſton, the vitriolic acid diſcovers itſelf by the ſmell like to the *hepar ſulphuris*.

It is found in a diſſolved ſtate in ſprings and wells, and in a dry form on walls, in ſuch places where aphronitrum has effloreſced through them, and the vitriolic acid has happened to be preſent; for inſtance, where marcaſites are roaſted in the open air. This ſalt is often confounded with the aphronitrum, or a pure mineral alcali; and a learned diſpute once aroſe, which of theſe ſalts ought with the greateſt propriety to be called natron, *Baurach veterum*, *ſal mirabile*, or Epſom ſalt; whereas it might eaſily have been decided by chemical experiments,

celebrated experiments of Lemery, and others, demonſtrate, and from which cauſe many volcanos and earthquakes may perhaps be deduced. The *pulvis pyrophorus* is alſo made of alum, intimately united with a phlogiſtic ſubſtance; in the preparing of which, they ought carefully to avoid that any iron enters the mixture, becauſe the acid has too ſtrong an attraction to the iron, and cannot unite with the phlogiſton alone, which, however, is quite neceſſary in this operation.

periments, if their qualities had been regarded, in preference to their figures, or their native places.

This may be called English or Epsom salt, when it has naturally as equal a copious portion of the calcareous earth as of the artificial one; but I have, in regard to its effects, for which it has been most valued by Glauber, ranked all the less considerable varieties of this neutral salt, when natural, under the name of *sal mirabile.*

SECT. CXXVII.

B. Acid of common or sea-salt, *Acidum salis communis.*

This acid, considered in that state in which it can be had, viz. in mixture with water, has the following qualities.

1. It does not alter the fluidity of water, nor considerably augment its heaviness, as the vitriolic acid does.
2. It is somewhat less corrosive and sour than the said vitriolic acid.
3. It strongly attracts the alcaline salts; but, however, is forced to quit them to the vitriolic acid, when that is added.
4. It dissolves the calcareous earth, and makes with it a substance, called *sal ammoniacum fixum.*
5. When exposed to the fire, combined with a phlogiston, it burns with a yellowish green flame.
6. When highly concentrated and pure, as when it is distilled from common salt mixed with pipe clay, it dissolves tin and lead: but

but leſs pure, it diſſolves copper, iron, zink, and the regulus of antimony: the copper is however more eaſily diſſolved, when it is in form of a calx, as the calces of quickſilver and cobalt likewiſe are.

7. It unites with ſilver diſſolved in aqua-fortis, and with lead diſſolved in aqua-regia, falling with them to the bottom, in form of a white ſpongy maſs. This precipitation, expoſed to the fire, ſtill retains the acid, and melts with it into a glaſſy ſubſtance, which does not diſſolve in water.

8. It is apt to attract the humidity of the air, and to promote the decaying of thoſe dry ſubſtances, with which it has been united.

9. Mixed with the ſpirit of nitre, it makes the ſo called aqua-regia, which is the true liquid menſtruum for gold.

This acid ſeems alſo, on certain occaſions, to have got looſe from thoſe ſubſtances, with which it has been originally united in the earth: the *ſal ammoniacum naturale* at Solfatara in Italy, and the horn ſilver ore (clxxvii.) appear to be proofs of this, as they ſeem to be the products of time.

SECT. CXXVIII.

1. Mixed or ſatiated acid of ſea-ſalt, *Acidum ſalis heterogeneis ſaturatum.*

A. With earths, *Terris ſaturatum.*

1. With a calcareous earth, *Terrâ calcareâ ſaturatum: Sal ammoniacum fixum.*

This ſomewhat decays or attracts the humidity of the air: it is found in abundance

abundance in the ſea-water. See the calcareous kind, Sect. xxi.

SECT. CXXIX.

B. With alcaline ſalts, *Salibus alcalinis ſaturatum.*

1. With the fixed mineral alcali, or ſea alcali, common ſalt, or ſea-ſalt, *Sal commune.*

This ſhoots into cubical criſtals during the very evaporation, it crackles in the fire, and attracts the humidity of the air.

a. Rock ſalt, foſſil ſalt, *Sal montanum.*

Occurs in form of ſolid ſtrata in the earth.

1. With ſcaly and irregular particles, *Sal montanum particulis indeterminatis.*

a. Grey, and

b. White. Theſe are the moſt common, but the following are ſcarcer.

c. Red,

d. Blue, and

e. Yellow, from Cracow in Poland, England, Salzberg, and Tirol.

2. Criſtallisſed rock ſalt, *Sal montanum cryſtalliſatum. Sal gemmæ.*

a. Tranſparent, from Cracow in Poland, &c.

SECT. CXXX.

b. Sea Salt, *Sal marinum.*

Is produced from ſea-water, or from the water of ſalt lakes, by evaporation in the ſun, or by boiling.

The

The ſeas contain this ſalt, though more or leſs in different parts. In Siberia and Tartary there are lakes that contain great quantities of ſalt.

SECT. CXXXI.

c. Spring ſalt, *Sal fontanum.*

Is produced by boiling the water of the fountains near Halle in Germany, and other places. Near the city of Lidkoping, in the province of Weſtergottland, and in the province of Dal, ſalt-ſprings are found, but they contain very little ſalt: and ſuch weak water is called *ſolen* by the Swedes *.

SECT. CXXXII.

2. Saturated with a volatile alcali, *Acidum ſalis communis alcali volatili ſaturatum.* Native ſal ammoniac, *Sal ammoniacum naturale.*

This is of a yellowiſh colour, and is ſublimed from the flaming fents or crevices at the Solfatara near Naples. See Sect. cxli.

* This diviſion of the natural common ſalts is generally adopted, and not without reaſon, ſince the taſte of all differs a little from one another, which depends on the leſs or greater mixture with heterogeneous ſubſtances. For out of the pureſt of theſe ſalts, a little of an earthy ſubſtance may ſtill be precipitated, which diſſolves in acids, and ſeems to be of a calcareous nature. The naturaliſts have troubled themſelves a great deal to find out, how common ſalt is produced in the earth, and from whence the great ſtore of it in the ocean is ſupplied: but they have propoſed nothing but conjectures, without any wiſe illuſtrating the main queſtion.

SECT. CXXXIII.

C. United with phlogiston, *Acidum alis communis phlogisto saturatum.* Amber, *Succinum.* See Sect. cxlvi. *

SECT. CXXXIV.

D. United with metals, *Acidum salis metallis saturatum.*

1. With silver, *Acidum salis communis argento saturatum. Minera argenti cornea,* Horn silver ore. The *Hornertz* of the Germans. See Sect. clxxvii.

SECT. CXXXV.

The Second Order.

Alcaline Mineral Salts, *Alcalia Mineralia.*

These are known by their action on the above-mentioned acids, when they are joined together, whereby a fermentation arises, and a precipitation ensues of such bodies as either of them had before kept in dissolution;

* The dry volatile salt of amber, which discovers itself to possess the qualities of an acid, is, according to Mr. Bourdelin's experiments, communicated to the French Academy, compounded of the acid of common salt, and a phlogiston, both which substances are said likewise to make out the constituent parts of the yellow amber itself, though in different proportion than in the salt: for this reason, and until this opinion is refuted by other experiments, the salt of amber cannot be considered as a mineral salt, that is different from the others, and consequently existent by itself; nor can the vitriolic acid be said to coagulate the yellow amber.

uniting

uniting at the ſame time together, by which new compoſitions are made, that are called neutral ſalts, or *ſalia neutra.*

Theſe alcaline ſalts are,

SECT. CXXXVI.

1. Fixed in the fire, *Alcalia mineralia fixa.*

A. Alcali of the ſea, or common ſalt, *Alcali ſalis communis, propriè minerale dictum.*

1. Pure, *Purum.*

This has nearly the ſame qualities with the lixivious ſalt, which is prepared from the aſhes of burnt vegetables; it is the ſame with the *ſal ſodæ,* or kelp, becauſe the kelp is nothing elſe than the aſhes remaining after the burning of certain herbs that abound in common ſalt; but which common ſalt, during the burning of thoſe vegetables, has quitted its acid.

This,

1. Ferments with acids, and unites with them.
2. Turns the ſyrup of violets to a green colour.
3. Precipitates ſublimate mercury in an orange-coloured powder.
4. Unites with fat ſubſtances to make ſoap.
5. Diſſolves the ſiliceous earth in the fire, and makes glaſs with it, &c. It diſtinguiſhes itſelf from the ſalt of the pot-aſhes, by the following properties: that,
6. It ſhoots eaſily into priſmatical criſtals, that

7. Fall

7. Fall to powder in the air, which is effected by nothing elſe, than that they eaſily loſe their humidity.
8. Mixed with the vitriolic acid, it makes the *ſal mirabile.*
9. It melts eaſier, and is fitter for producing the *ſal commune regeneratum, nitrum cubicum,* &c. Perhaps it is alſo more conveniently applied in the preparation of ſeveral medicines.
10. It is ſomewhat volatile in the fire *.

SECT. CXXXVII.

2. Mixed with a ſmall quantity of the calcareous earth, *Alcali ſalis communis terræ calcareæ parvâ portione combinatum. Aphronitrum.*

* This ſalt is not met with pure in Europe, but it is ſaid to be found in both the Indies, not only in great quantity, but likewiſe of a tolerable purity; it is there collected in form of an efflorescence in the extenſive deſerts, a profitable trade being carried on in it for the making of ſoap and glaſs: and therefore it is very probable, that the antients meant this ſalt by their *natron*, or Baurach. The calcareous earth is ſuſpected either to contain this ſalt in its own compoſition, or elſe to be able to generate it from itſelf: but this hypotheſis cannot be demonſtrated. It is more probable, that the heat of the ſun under the equator, and in the countries on both ſides of it, evaporates the humidity, and afterwards expels the acid out of ſome common ſalt, which either is naturally mixed with the earth, or elſe has been depoſited there through the means of certain decayed vegetables, that always attract this ſalt; becauſe an earth from Paleſtine, which Dr. Haſſelquiſt ſome years ago ſent to Sweden, as a matrix of the natron, did upon trial yield nothing but a common ſalt: and it might, perhaps, have been taken at ſuch a great depth, that it had not yet ſuffered any decompoſition. But this matter wants to be more illuſtrated by obſervations, which might be beſt made in the Eaſt-Indies, where the greateſt quantity is to be had, and alſo by ſome farther analyſes of the ſubſtance.

This

This is ſo ſtrongly united with the calcareous earth, that the latter enters with it into the very criſtals of the ſalt: though by repeated ſolutions the earth is by degrees ſeparated from it, and falls to the bottom after every ſolution. It grows in form of white froſt on walls, and under vaults, and in places where it cannot be waſhed away by the rain. When it contains any conſiderable quantity of the calcareous earth, its criſtals become rhomboidal, a figure which the calcareous earth often aſſumes in ſhooting into criſtals: but when it is purer, the criſtals ſhoot into a priſmatical figure. This is a circumſtance which neceſſarily muſt confuſe thoſe who know the ſalts only by their figure, and ſhews, at the ſame time, how little certainty ſuch external marks afford in a true diſtinction of things. This ſalt is therefore very often confounded with the *ſal mirabile.*

SECT. CXXXVIII.

3. Saturated with mineral acids, *Alcali ſalis communis acidis mineralibus ad ſaturitatem mixtum.* Neutral ſalts, *Salia media, ſalia neutra.*

a. With the acid of ſea-ſalt, common ſalt, ſea-ſalt, *Sal commune.* Sect. cxxix.

b. With the vitriolic acid, *Sal mirabile.* Sect. cxxvi.

SECT.

SECT. CXXXIX.

B. Borax.

This is a peculiar alcaline ſalt, which is ſuppoſed to belong to the mineral kingdom, and cannot be otherwiſe deſcribed, than that it is either ſome unknown alcali, united with an earth; which is diſſoluble in water, and vitreſcible; or an alcaline ſalt, which is fixed in the fire, and melts to a glaſs, which glaſs is afterwards diſſoluble in water.

Many experiments have been made with it, in order to diſcover its origin and conſtituent parts, and therefore it is amply treated of in chemical books; and its following qualities are to be obſerved.

1. It ſwells and froths in the fire, as long as any humidity remains in it, but melts afterwards very eaſily to a tranſparent glaſs, which, as it has no attraction to the phlogiſton, keeps itſelf in the form of a pearl on the charcoal, when melted with the blowpipe.
2. It changes the ſyrup of violets into green; and precipitates the ſolution of allum, and that of metals, made with acids.
3. It unites with mineral acids to a neutral ſalt, which ſhoots into very fine and ſubtile hair-like criſtals, and is called *ſal ſedativum*. In a certain compoſition it is volatile; and mixed with *litmus*, or *ſuccus heliotropii*, and the ſyrup of violets, it diſcovers marks both of an alcali and an acid.
4. When it has been united with the vitriolic acid and a phlogiſton, no *hepar ſulphuris* is produced.

5. After being refined, it ſhoots into irregular figures: but the cryſtals, which form themſelves after the firſt operation, and are called *Tincal*, conſiſt of flat octagonal priſms, flat at the extremities, and with their angles cut off or truncated *.

* It is yet unknown of what ſubſtance the Eaſt-Indians and Chineſe prepare the borax. The unrefined, which is brought to Europe under the name of *tincal*, looks like ſoft ſoap, is fat, and covers or encruſts the borax criſtals. The mine-maſter Mr. Swab, who has had an opportunity of making experiments upon this *tincal*, has publiſhed them in the Acts of the Royal Academy of Sciences at Stockholm for 1756. He ſays, that he has found in it a martial earth, and a fat ſubſtance, which, to ſmell and other circumſtances, comes neareſt to a mineral fat: as likewiſe, that pure borax does not yield any *hepar ſulphuris*, when united with a phlogiſton and a vitriolic acid; from which he concludes, that borax is prepared from its own particular mineral ſubſtance.

Profeſſor Pott and Mr. d'Henouville have very carefully examined the refined borax; and from their experiments, which have been publiſhed, it is evident, that it is of a particular alcaline nature: however, there yet remains to know for certain, from what it is prepared by the Indians: for, if it is produced from a mineral ſubſtance, as is very probable, there muſt exiſt other mixtures and compoſitions, which are yet unknown to the learned world.

I have alſo found in the *tincal* ſmall bits of leather, bones and ſmall pebbles, whence there is no certainty to be concluded on from its examination; but, if it ſhould happen, that it is prepared from animal ſubſtances, it muſt be allowed, that nature has formed an alcaline ſalt in the animal kingdom, which anſwers to the fixed acid ſalt in the human urine, called *ſal fuſibile microcoſmicum*, and which has been firſt accurately deſcribed by Mr. Margraff, in the Memoirs of the Academy of Berlin.

Some years ago a report was propagated from Saxony, that ſomebody had there diſcovered a ſubſtance out of which borax could be made, and alſo the art of preparing it: but nothing more has ever tranſpired ſince, than that the author ſhewed it in ſecret to his friends, and gave a deſcription of it, which only was intended to miſlead them, if he really did poſſeſs the art.

SECT.

SECT. CXL.

2. Volatile alkali, *Alcali minerale volatile.*

This perfectly reſembles that ſalt which is extracted from animals and vegetables, under the name of *alcali volatile*, or *ſal urinoſum*, and is commonly conſidered as not belonging to the mineral kingdom; but ſince it is diſcovered not only in moſt part of the clays, but likewiſe in the ſublimations at Solfatara near Naples, it cannot poſſibly be quite excluded from the mineral kingdom.

Its principal qualities are that,

a. In the fire it riſes in *forma ſicca*, and volatiliſes in the air, in form of corroſive vapours, which are offenſive to the eyes and noſe.

b. It precipitates the ſolution of the mercurial ſublimate into a white powder.

c. It alſo precipitates gold out of *aqua regia*, and detonates with it, becauſe

d. It has a reaction in regard to the acids, though not ſo ſtrongly as other alcalies.

e. It tinges the ſolution of copper blue, and diſſolves this metal afreſh, if a great quantity is added.

f. It deflagrates with nitre, which proves that it contains a phlogiſton.

It is never found pure, but

SECT. CXLI.

A. Mixed with

1. Salts, *Alcali minerale volatile ſalibus mixtum.*

 a. With

a. With the acid of common ſalt, *Alcali minerale volatile acido ſalis unitum.* Native ſal ammoniac, *Sal ammoniacum nativum,* Sect. cxxxii *.

SECT. CXLII.

2. With earths.

a. Clay, *Alcali minerale volatile argillâ mixtum.*

The greateſt part of the clays contain a volatile alcali, which diſcovers itſelf in the diſtillation of the ſpirit of ſea-ſalt, &c. †

* If that hypotheſis could be proved true, which holds that volcanos and ſubterranean fires ariſe from ſlates, formed from vegetables, animals, and the *humus ater* or mould, mixed together, (Sect. cxxiv.) the origin of the ſal ammoniac at Solfatara would eaſily be acknowledged; ſince we know that petrifactions diſcover a principle within them, which contains the *ſal urinoſum.*

† In caſe ſome of the clays are produced from the mould or *humus ater* (Sect. xci.) it is not difficult to ſee the reaſon of the preſence of this alcali in them; but, though it would be both uſeful and curious to know all the changes of minerals, yet it is much better to take and employ them in their preſent ſtate, than to lead the mind into perplexities by examining the combinations of theſe things by other means than by what the external ſenſes ſhew, and by rational experiments.

A German author has lately aſſerted, that metals, according to his experiments, have been found diſſolved or mineraliſed by a volatile alcali; but, beſides that ſome ſubjects mentioned by him; for inſtance, the *Sinople,* or Red Chalk; the *Hungarian Gilben,* or Vein Stones; and the *Horn Silver ore*; do not ſhew the leaſt mark of it; there is alſo wanted a deſcription of the experiments he has made, and of the phœnomena which have preſented themſelves to him, during the examination of the other ores which he has mentioned: for theſe reaſons his opinion cannot yet be admitted.

SECT.

SECT. CXLIII.

Observations on Salts.

The perfect knowledge of these bodies must be had from chemical books and practical chemistry, being almost the chief subject of that science. From thence we likewise learn why the acids are considered as salts, though a certain figure neither is found, nor can reasonably be expected in them. We are farther taught, that the angular figure, which is supposed to be essential to salts, and by its varieties to mark out their different species, depends on an alcali, earth, and metals, united with more or less water: for else, if this was not so, the cristal of alum and vitriol ought to be of the same figure, no *nitrum cubicum* would exist, nor could any cristallisation happen in such cases, where the acids necessarily must be parted (Sect. xi.).

Salts are contained in all the three kingdoms of nature; and as it is not yet known how the changes happen, and how far the varieties depend on one another, we cannot attribute to the mineral kingdom any other salts than those which are found truly changed in the earth.

The use of the salts in medicine and in common life is so great, that it would require a separate treatise, if it were to be fully discussed. Mean while, every one who applies himself to the study of mineralogy, in order to learn the use to which the mineral bodies can be employed in common life, I mean in particular mines, must endeavour to discover where salts may be found, and how they must be prepared, so as to be best fit for use. But the preparation of salts is not the subject of

 this

this work; they are here only deſcribed, ſuch as they are naturally found, *viz.* entangled in certain heterogeneous bodies, of which they require but very little for their ſaturation.

SECT. CXLIV.

The THIRD CLASS.

MINERAL INFLAMMABLE SUBSTANCES,

Phlogiſta Mineralia.

To this claſs belong all thoſe ſubterraneous bodies that are diſſoluble in oils, but not in water, which they repel; catch flame in the fire; and are electrical.

It is difficult to determine what conſtitutes the difference between the purer ſorts of this claſs, ſince they all muſt be tried by fire, in which they all yield the ſame product; but thoſe which in the fire ſhew their differences by containing different ſubſtances, are here conſidered as being mixed with heterogeneous bodies: that ſmall quantity of earthy ſubſtance, which all phlogiſta leave behind in the fire, is, however, not attended to.

SECT. CXLV.

1. Amber griſe, *Ambra griſea.*

Is commonly reckoned to belong to the mineral kingdom, although it is ſaid to have doubtful marks of its origin.

a. It has an agreeable ſmell, chiefly when burnt.

b. It is conſumed in an open fire.

c. It

c. It ſoftens in a common degree of heat, ſo as to ſtick to the teeth like pitch.

d. It is of a black or grey colour, and of a dull and fine-grained texture. The grey is reckoned the beſt, and is ſold very dear.

This drug is brought to Europe from the Indies; it is employed in medicine, and as a perfume.

SECT. CXLVI.

2. Amber, *Ambra flava*; *Succinum*, *Electrum*.

This is a ſubſtance which is dug out of the earth, and found on the ſea-coaſts. According to the experiments of Mr. Bourdelin, it conſiſts of an inflammable ſubſtance, united with the acid of common ſalt, which ſeems to have given it its hardneſs. It is ſuppoſed to be of vegetable origin, ſince it is ſaid to be found together with wood in the earth. By diſtillation it yields water, oil, and a volatile ſalt, which the abovementioned author has found to be the acid of common ſalt, united with a little of the phlogiſton. There are often found fiſh, inſects, and vegetables included in it, which teſtify its once having been liquid. It is more tranſparent than moſt part of the other bitumens, and is doubtleſs that ſubſtance which firſt gave riſe to electrical experiments.

Its varieties are reckoned from the colour and tranſparency: it is found

A. Opake, *Succinum opacum.*

- *a.* Brown.
- *b.* White.
- *c.* Blackiſh.

B. Tranſparent, *Succinum diaphanum*.

a. Colourleſs.

b. Yellow.

The greateſt quantity of European amber is found in Pruſſia; but it is, beſides, collected on the ſea-coaſt of the province of Skone, and at Biorko, in the Lake Malaren, in the province of Upland; as alſo in France and in Siberia. It is chiefly employed in medicines, and for making varniſhes.

SECT. CXLVII.

3. Rock-oil, *Petroleum*.

It is an inflammable mineral, of a light-brown colour, which cannot be decompounded, but is often rendered impure by heterogeneous admixtures. In length of time, it hardens in the open air, like a vegetable reſin, and then becomes of a black colour, whether it is pure, or mixed with other bodies. It is likewiſe found in the earth

A. Liquid.

1. Naphta, *Naphta*.

This is ſaid to be of a very fragrant ſmell, tranſparent, extremely inflammable, and attracts gold. It is gathered from the ſurface of the water in ſome wells in Perſia.

SECT. CXLVIII.

2. Rock-oil, *Petroleum, propriè ſic dictum*.

This ſmells like the oil of amber, though more agreeable, and is likewiſe very ready to take fire. It is collected

in

in the ſame manner as the Naphta, from ſome wells in Italy, and in a deſerted mine at Oſmundſberget in the province of Dalarne: at this laſt-mentioned place it is found in ſmall hollows in the lime-ſtone, as reſin is in the wood of the pines.

SECT. CXLIX.

B. Thick and pitchy Rock-oil, or Barbadoes Tar, *Petroleum tenax*, *Maltha*.

This reſembles ſoft pitch.

It is found in Moſſgrufvan, at Norberg, in the province of Weſtmanland, and at the Dead Sea in the Holy Land.

SECT. CL.

C. Hardened Rock-oil, *Petroleum induratum.* Foſſil Pitch, *Pix montana.*

1. Pure, *Aſphaltum.*

This leaves no aſh or earthy ſubſtance when it is burnt.

It is found at Finnberget, in the pariſh of Grythytta, in Weſtmanland.

From this or the preceding ſubſtance, it is probable, the aſphaltum was prepared that the Egyptians uſed in embalming their dead bodies, and which is now called *Mummia.*

2. Impure, *Pix montana impura.*

This contains a great quantity of earthy matter, which is left in the retort after diſtillation, or upon the piece of charcoal, if burnt in an open fire; it coheres like a ſlag, and is of the colour of black lead: but in a calcining heat this

this earth quickly volatilises; so that the nature of it is not yet known.

It is found in Mossgrufvan at Norberg, and in Grengierberget, both in the province of Westmanland, and also in other places *.

SECT. CLI.

4. Mineral Phlogiston, or Bitumen, united with the vitriolic acid, *Phlogiston minerale acido vitrioli junctum*. Sulphur or Brimstone, *Sulphur*.

This is very common in the earth, and discovers itself in many and various forms. It is found,

A. Native Sulphur, *Sulphur nativum*.

In this the two constituent parts are mixed in due proportion in regard to each other, according to the rules of that attraction which is between them; it is easily known,

1. By its inflammability, and by its flame.
2. By its smell, when burnt; and,
3. By its producing a liver of sulphur, when mixed with a fixed alkali, like that made from artificial sulphur.

It is found

a. Pellucid, of a deep yellow colour.

b. Opake, white and greyish.

These are found in Siberia, at Bevieux in Switzerland, and at Solfatara near Naples. It is often found on limestone, which the vitriolic acid has left untouched, having a stronger attraction to the

* The substance which rises, and then falls into the receiver during the distillation of this fossil pitch, is entirely the same as the common natural liquid rock-oil, Sect. cxlviii.

the phlogiſton, and therefore wholly uniting with that.

SECT. CLII.

B. Sulphur that has diſſolved, or is ſaturated with metals, *Sulphur metallis ſaturatum.*

1. With iron, *Sulphur marte ſaturatum.* Pyrites, or Copperas-ſtone, *Pyrites.*

This is the ſubſtance from which moſt ſulphur is prepared, and is therefore ranked here with all its varieties. It is hard, and of a metallic ſhining colour.

a. Pale yellow Pyrites, *Pyrites ſubflavus.* Marcaſite.

This is very common, and contains a proportionable quantity of ſulphur with reſpect to the iron; when once thoroughly inflamed, it burns by itſelf.

1. Of a compact texture, *Texturâ æquali: PolitaPiedra del Ynca, Hiſpanorum.*
2. Steel-grained, *Texturâ chalybeâ.*
3. Coarſe-grained, *Texturâ granulatâ.*
4. Criſtalliſed, *Chriſtalliſatus.*

It ſhoots moſtly into cubical and octoedral figures, though it alſo criſtalliſes into innumerable other forms.

SECT. CLIII.

b. Liver-coloured Marcaſite, *Pyrites colore rubeſcente.*

Its colour cannot be deſcribed, being betwixt that of the preceding marcaſite, and the azure copper ore. When

When it is of a light colour, it is called in Swedish *Tennbett*, or *Wattnkies*, but *Lefverslag* when it is of a deeper colour.

The iron prevails in this kind; it is therefore less fit to have sulphur extracted from it, and also for the smelting of copper ores. It is found

1. Of a compact texture, from Nya Kopparberget in the province of Westmanland.
2. Steel-grained, from Stollberget in Westmanland.
3. Coarse-grained, from Westersilfverberget in Westmanland.

SECT. CLIV.

2. Iron and Tin, *Sulphur ferro & stanno saturatum.* Black Lead, or Wadd, *Molybdæna.*

If by such a mixture as this the iron and tin be not rendered too volatile, it must be supposed that the great loss the Black Lead sustains in the calcining heat is occasioned from the sulphur, and that the sulphur consequently makes out the greatest part of the black lead. It is found,

a. Lamellar and shining, of the same colour as the potters lead ore, *Molybdæna membranacea nitens.*

From Bispergs Klack in the province of Dalarne, Bastnas-grufva at Riddarshyttan in Westmanland, Altenburg in Saxony.

The

The variety from Bispergs Klack has been examined by Mr. Quist, and has, by its volatilising under the muffel, in form of a white fibrous sublimate, induced that gentleman to examine the black lead more particularly; and he has published some very remarkable experiments on it in the Transactions of the Academy of Sciences at Stockholm, for the year 1754.

b. Of a steel-grained and dull texture, *Texturâ chalybeâ.* It is naturally black, but when rubbed it gives a dark lead colour.

c. Of a fine scaly and coarse-grained texture, *Texturâ micaceâ & granulatâ.* Coarse Black Lead.

It has at the same time a scaly and a granulated appearance.

From Gran in the province of Upland, and from Tavastehuslan in Finland *.

* Professor Pott has examined the black lead in covered vessels, and Mr. Quist in an open fire, from which difference in the method of treating it, different notions have arose: because the black lead is nearly unalterable when exposed to the fire in covered vessels, or when immediately put into a strong charcoal fire, but it is almost wholly volatile in a calcining heat. This is the case with several others of the mineral phlogistons; and from this we may in general learn, how necessary it is to examine the mineral bodies by many and different methods, and to endeavour to multiply the experiments more than what has been hitherto done. Pencils are made from the black lead; as also the black lead crucibles.

SECT. CLV.

3. Sulphur with iron and copper, yellow or marcasitical copper ore. See Sect. cxcviii.
4. Sulphur with iron and lead, Potters lead ore. See Sect. clxxxix.
5. Sulphur with iron and zinc, mock lead, black jack, or blende. See Sect. ccxxix.
6. Sulphur with iron and arsenic, arsenical pyrites. Sect. ccxliii.
7. Sulphur with iron and cobalt. Sect. ccl.
8. Sulphur with iron and bismuth. Sect. ccxxv.
9. Sulphur with iron and nickel. Sect. cclvi.
10. Sulphur with iron and gold, pyritical gold ore. Sect. clxvi.

SECT. CLVI.

11. Sulphur with silver, glass silver ore. Sect. clxix.
12. Sulphur with copper, grey or vitreous copper ore. Sect. cxcvii.
13. Sulphur with lead, Potters lead ore. Sect. clxxxvii.
14. Sulphur with bismuth. Sect. ccxxiv.
15. Sulphur with quicksilver, cinnabar. Sect. ccxviii.
16. Sulphur with arsenic, Orpiment, Realgar. Sect. ccxli.

SECT. CLVII.

5. Mineral phlogiston united with earths, *Phlogiston minerale terris imbutum.*

A. With a calcareous earth, *Phlogiston minerale terrâ calcareâ imbutum.*

1. With pure calcareous earth, the fœtid or swine spar, Sect. xxiii.
2. With the calcareous earth and vitriolic acid, the Leberstein or Liverstone of the Swedes, Sect. xxiv.

SECT. CLVIII.

B. With an argillaceous earth, *Phlogiston argillâ mixtum.*

1. With a small quantity of argillaceous earth and vitriolic acid: Coal: Lithantrax.

It is of a black colour, and of a shining texture; it burns, and is mostly consumed in the fire; but leaves however a small quantity of ashes.

a. Solid coal.
b. Slatty coal

Found in England, and at Boserup in the province of Skone.

SECT. CLIX.

2. With a greater quantity of argillaceous earth and vitriolic acid, the Kolm of the Swedes. This is of the same appearance with the former, though of a more dull texture; it burns with a flame, and yet is not consumed, but leaves behind a slag of

of the ſame bulk or volume as the coal was.

From England, and among the alum rock at Moltorp and Billingen in the province of Weſtergottland.

SECT. CLX.

3. With abundance of argillaceous earth, Stone coal. It burns with a flame by itſelf, otherwiſe it looks like other ſlates.

It is found at Gulleraſen, in the pariſh of Rettwik, in the province of Dalarne, and alſo with the coals at Boſerup in Skone *.

SECT. CLXI.

6. Mineral phlogiſton mixed with metallic earths, *Phlogiſton minerale metallis impregnatum.*

This is not found in any great quantity: in regard to its external appearance, it reſembles pit-coal; and the fat ſubſtance contained in it, at times partly burns to coal, and partly volatilizes in a calcining heat.

The only known varieties of this kind are,

A. Minera cupri phlogiſtica.

When it has been inflamed, it retains the fire, and at laſt burns to aſhes, out of which

* This laſt mentioned kind has induced me to believe, that the earth of the pit-coals is an argillaceous one, but is not ſo eaſy to be diſcovered after its being burnt. The pit-coals contain more or leſs of the vitriolic acid, for which reaſon the ſmoak ariſing from them attacks ſilver in the ſame manner as ſulphur does; though the coals be ever ſo free from marcaſite, which however is often found imbedded or mixed with them.

pure

pure copper can be ſmelted. It is found in Sladkierr's Grufva in the province of Dal, and at Biſpergs Klack, in the province of Dalarne.

B. *Minera ferri phlogiſtica.*

This is not very different in its appearance from the pit-coal or foſſil pitch; but it is ſomewhat harder to the touch: there are two varieties of this ſpecies:

1. Fixt in the fire, *Minera ferri phlogiſtica fixa.*

Expoſed to a calcining heat, it burns with a very languid though quick flame, it preſerves its bulk, and loſes only a little of its weight. It yields above 30 per cent. of iron.

a. Solid, reſembles black ſealing-wax.

It is found in the liver-coloured marcaſite, (Sect. cliii.) in Waſkberget, at Norrberke, in Weſtmanland.

b. Cracked, and friable, from Finnberget, at Grythyttan, in Weſtmanland.

2. Volatile in the fire, *Minera ferri phlogiſtica volatilis.*

This is unalterable in an open fire, either of charcoal, or even upon a piece of charcoal before the flame of the blowpipe: but under a muffel the greateſt part of it volatiliſes, ſo that only a ſmall quantity of calx of iron remains. It is found,

a. Solid, from Kronprints Shurff, at Kongſberg, in Norway.

b. Cracked, from the pariſh of Quiſtbro, in the province of Nerike.

This laſt kind leaves more aſhes: theſe aſhes, when farther expoſed to the fire, become firſt yellowiſh green, and afterwards reddiſh brown, when, beſides iron, they then alſo diſcover ſome marks of copper; it has however not been poſſible to extract any metallic ſubſtance from them, the effects of the loadſtone, and the colour communicated to the glaſs of borax, having only given occaſion to this ſuſpicion (conf. Sect. cl. & cliv.).

SECT. CLXII.

OBSERVATION on the BITUMENS.

That ſubſtance which the chemiſts call Phlogiſton, or an inflammable principle, exiſts in moſt of the mineral bodies, though often in ſo ſmall a quantity as not to be perceived; and therefore I have here only enumerated thoſe kinds in which it exiſts as a principal character; for inſtance, in the fœtid ſpar or ſwine-ſtone, &c.

I do not myſelf know the ſubſtance in its ſimple ſtate which I call a mineral phlogiſton, ſince the ambergriſe and the rock-oil can be nothing elſe than compoſitions which cannot be perfectly decompounded; and beſides, they are not to be extracted from coal, ſulphur, &c. which yet contain an inflammable ſubſtance. It ſeems as if a great part of this claſs were originally generated from the animal and vegetable kingdoms; ſo that they firſt have been an *humus ater* or mould, with which a vitriolic acid has afterwards been mixed; and that they have been beſt able to retain this phlogiſton, when they have been covered and joined together by another earth: the coal, coal ore, and pitch turff, (Sect. ccxciii.) give ſome hints or reaſons

reasons for this supposition. The generation of sulphur and marcasite requires no preferable phlogiston out of any of the kingdoms of Nature, for the phlogistons throughout all nature are equally alike fit for it.

It is a sublime subject for philosophers to enquire how far fire, phlogiston, and electricity, have an affinity with, or dependance on, one another; but as they yet want that light in this matter which they wish to have, I hope to be excused for not mentioning any theories on the subject.

This class is of great use in medicine; for instance, the ambergrise, the salt of the yellow amber, the rock-oil, the asphaltum, and the sulphur. The rock-oil and sulphur are used in fireworks, the asphaltum by the watchmakers, and the yellow amber is used by the varnishers and painters *.

SECT. CLXIII.

The FOURTH CLASS.

METALS, *METALLA*,

Are those mineral bodies which, with respect to their volume, are the heaviest of all hitherto-known bodies; they are not only malleable, but they may also be decompounded, and in a melting heat be brought again to their former state,

* The coals, however, are of the greatest consequence for their œconomical use; and happy therefore are those countries which have a sufficient quantity of them, since they may be employed as fuel to almost every purpose, which is plainly proved in England. E.

by the addition of the phlogiston they had lost in their decomposition *.

SECT. CLXIV.

The First Order.

Metals, *Metalla.*

1. Gold, *Aurum, Sol Chymicorum.*

This is by mankind esteemed as the principal and first among the metals; and that partly for its scarcity, but chiefly for its following qualities.

1. It is of a yellow shining colour.
2. It is the heaviest of all known bodies, its specific gravity to water being as 19,640 to 1000.
3. It is the most tough and ductile of all metals; because one grain of it may be stretched out so as to cover a silver wire of

* Those metals which in a calcining heat lose their phlogiston, and consequently with that the former coherency of their particles, are called *imperfect*, as tin, lead, copper, and iron, and all the semi-metals (of which more hereafter): notwithstanding which they may be malleable. But those which cannot be destroyed in the fire alone are called *perfect*, as gold, silver, and platina del pinto. Nevertheless, the metals have commonly been considered more with regard to their malleability than to their fixity in the fire, and are therefore divided into,

A. Malleable, which are called *metals*; and

B. Brittle, which are called *semi metals*.

The zinc is, however, as a medium between these two divisions, just as the quicksilver is between the perfect and imperfect metals, because the quicksilver may indeed be so far destroyed in the fire, that its particles are separated during their volatilisation; but every one of them, even the minutest, retains however the phlogiston united with it.

the

the length of ninety-eight yards, by which means $\frac{1}{705600}$ grain becomes visible to the naked eye.

4. Its softness comes nearest to that of lead, and consequently it is but very little elastic.
5. It is fixed and unalterable in air, water, and fire, because it does not easily quit its phlogiston; its liquid menstruum (7°) being only made by art.

   It has, however, according to Homberg's experiments, when exposed to Tschirnhausen's burning-glass, been found partly to volatilise in form of smoke, and partly to scorify: But this wants to be farther examined. It is also said, that gold in certain circumstances, and by means of certain artifices in electrical experiments, may be forced into glass; and that on this occasion it becomes white, leaving a black dust behind it; which, if so, confirms certain other chemical experiments; viz. That gold can, together with its colour, lose something of its phlogiston, and yet retain its heaviness, ductility, &c.
6. When melted, it reflects a blueish green colour from its surface.
7. It dissolves in aqua regia, which is composed of the acids of sea-salt and nitre; but not in either alone, nor in any other solution of salt or acid whatsoever.
8. When mixed with a volatile alcali and a little of the acid of nitre, by means of precipitation out of aqua regia, it burns off quickly, in the least degree of heat, with a strong fulmination.

9. It is diſſolved, *in formâ ſiccâ*, by the liver of ſulphur, and alſo ſomewhat by the glaſs of biſmuth.

10. It is not carried away by the antimony during the volatiliſation of that ſemi-metal, and is therefore conveniently ſeparated from other metals by the help of crude antimony, in which proceſs the other metals are partly made volatile, and fly off with the antimony, and partly unite with the ſulphur, to which the gold has no attraction, unleſs by means of ſome uniting body, or by a long digeſtion.

11. The phoſphorus is ſaid to have ingreſs into gold.

12. If mixed with a leſs portion of ſilver, platina, copper, iron, and zinc, it preſerves tolerably well its ductility; but,

13. When mixed with tin it becomes very brittle; and it attracts likewiſe the ſmoke of that metal, ſo as to be ſpoiled, if melted in an hearth where tin has been lately melted: And this is perhaps the reaſon why gold becomes brittle, and of a paler colour, when melted in a new black lead crucible (Sect. cliv.)

14. It requires a ſtrong heat before it melts, nearly as much, or a little more than copper.

15. It mixes or amalgamates readily with quickſilver.

16. It is not diſſolved by the glaſs of lead, and therefore remains on the cuppel.

In conſequence of theſe its principal qualities, it ſeems as if it could never be found in the earth but in a native or pure ſtate;

ſtate; there are, however, ſeveral inſtances that it has been found diſſolved or mineraliſed.

SECT. CLXV.

A. Native Gold, *Aurum nativum*,

Is in its metallic form commonly pure: And in this ſtate moſt part of this metal uſed in the world is found. With reſpect to either the figure or the quantity in which it is found in one place, it is by miners divided into,

1. Thin ſuperficial plated or leaved gold, which conſiſts of very thin plates or leaves, like paper.
2. Solid or maſſive, is found in form of thick pieces.
3. Criſtalliſed, conſiſts of an angular or criſtalline figure.
4. Waſh Gold, or Gold Duſt, is waſhed out of ſands, wherein it lies in form of looſe grains and lumps *.

* The gold is in general more frequently imbedded and mixed with quartz, than with any other kind of ſtone; and the quartz in which the gold is found in the Hungarian gold mines is of a peculiar appearance. All other ſorts of ſtones, however, are not to be excluded, ſince gold is likewiſe found in ſome of them; for inſtance, in limeſtone (Sect. ix.) in Adolph Fredrik's Grufva at Adelfors, in the province of Smoland; in Hornblende (Sect. lxxxviii.), in Baſtnas Grufva at Riddarſhyttan, in the province of Weſtmanland; not to mention ſeveral foreign gold mines.

The greateſt quantity of gold is imported into Europe from Chili and Peru, in America; and a little from China, and the coaſt of Africa. The chief European gold mines are thoſe of Hungary, and next to them thoſe at Saltzburg. Beſides theſe, there are ſome others of leſs conſequence; among which the gold mines at Adelfors in Smoland deſerve to be taken much notice of, not only on account of the veins already worked, but alſo in regard to the vaſt tract of land, within which new

SECT. CLXVI.

B. Mineralised Gold, *Aurum mineralisatum.*

This is an ore in which the gold is so far mineralised, or so entangled in other bodies, as not to be dissolved by the aqua regia.

1. Mineralised with sulphur, *Aurum sulphure mineralisatum.*

a. Mineralised by means of iron, *Aurum sulphure mineralisatum mediante ferro.* Marcasitical gold ore, *Pyrites aureus.*

It is found at Adelfors, in the province of Smoland, and contains an ounce of gold, or less, in an hundred pounds.

b. Mineralised by means of quicksilver, *Aurum sulphure mineralisatum mediante mercurio.*

It is found in Hungary.

c. Mineralised by means of zink and iron, *Aurum sulphure mineralisatum mediante zinco & ferro, aut argento.* The Schemnitz blende.

At Schemnitz in Hungary are found zink ores, which contain a great deal of silver, and this silver is very rich in gold (Sect. clxxv.) *.

veins are daily discovered. The silver from the mines at Oster-silverberget, in the province of Dalarne, contains about a fourth part of an ounce of gold in every pound of silver. Some native gold has likewise been found in Swappawari, above Tornea in Lapland, and in Bastnas, near Riddarshyttan in Westmanland.

* Since gold and sulphur have no immiscible power or attraction to one another, many have insisted that gold never could be found in marcasite, or those ores which contain sulphur; But since we know by experience, that gold can be melted

SECT. CLXVII.

2. Silver, *Argentum*, *Luna*; which is,
   a. Of a white ſhining colour.
   b. Its ſpecific gravity to water is 11,091 to 1000.
   c. It is very tough or ductile, ſo that a grain of it may be ſtretched out to three yards in length, and two inches in breadth.

melted out of the above-mentioned ores, altho' they have been previouſly digeſted in aqua regia; and that gold likewiſe mixes and diſſolves into a regulus; there is the greateſt reaſon to believe that a third ſubſtance, which here is a metal, muſt neceſſarily have by its admixture enabled the ſulphur to unite with a certain quantity of gold. Scheffer has given upon this ſubject ſome very curious and uſeful obſervations, in his Hiſtory of the Refining of Metals, inſerted in the Tranſactions of the Academy of Sciences at Stockholm. It is very remarkable that the Mine-Maſter Henckel, in his excellent Treatiſe *de Appropriatione*, ſhould be ſo obſtinate in denying that marcaſite could contain a diſſolved gold.

It is, however, by no means hereby intended to confirm the credulous in their opinion, that the marcaſites in general contain more gold than what true metallurgiſts have aſſerted; becauſe fraud might then perhaps become too common. It is only meant to indicate, that, as no gold is to be expected from marcaſites, where no native gold is found in the neighbourhood, in the ſame manner no marcaſites ought to be deſpiſed, which are found in tracks where gold ores are dug; but at the ſame time care muſt be taken not to be deluded by the mention of volatile gold, as it is a notion really contradictory and ſuſpicious, and then there can be no fear of being miſled.

I am not perfectly clear, if the gold is really diſſolved and indurated, or, if I may ſo expreſs myſelf, vitrified in the Shirls (Schirlkorrern), provided by this mineral body is meant a garnet ſubſtance (Sect. lxviii.) But I have ſeen a piece of what is called *Shirl*, whoſe texture was exactly like the Schemnitz blende; and in this caſe it might perhaps hold the ſame contents (Sect. clxxv.) For the other gold ores, I have not had an opportunity of ſeeing any from thoſe places where gold is ſearched for and really found.

d. It is unalterable in air, water, and fire.

e. It diſſolves in the acid of nitre, and alſo by boiling in the acid of vitriol.

f. If precipitated out of the acid of nitre with the common ſalt, or with its acid, it unites ſo ſtrongly with this laſt acid, that it does not part from it, even in the fire itſelf, but melts with it into a maſs like glaſs, which is called *luna cornea.*

g. It does not unite with the ſemi-metal nickel, during the fuſion.

h. It amalgamates eaſily with quickſilver.

i. It is in the dry way diſſolved by the liver of ſulphur.

k. It has a ſtrong attraction to ſulphur, ſo as readily to take a reddiſh yellow or black colour, when it is expoſed to ſulphureous vapours.

l. It has no attraction to arſenic; whence when the red arſenical ſilver ore, or *Rothgulden Ertz* of the Germans, is put into the fire, the arſenic flies off, and leaves the ſulphur (which in this compound was the *medium uniens*) behind, united with the ſilver in form of the glaſs ſilver ore, or glaſs ertz.

m. It is not diſſolved by the glaſs of lead, and conſequently it remains on the cuppel.

n. It is exhaled or carried off by volatile metals and acids, as by the vapours of antimony, zink, and the acid of common ſalt.

o. It melts eaſier than copper.

SECT.

SECT. CLXVIII.

Silver is found,

A. Native or pure, *Argentum purum nativum.*

Native ſilver moſt generally is nearly of ſixteen carats ſtandard.

1. Thin ſuperficial plated or leaved ſilver.
2. It is alſo found in form,
   a. Of ſnaggs, and coarſe fibres.
   b. Of fine fibres. Capillary ſilver.
   c. Arboreſcent. From Potoſi in America, and Kongſberg in Norway.
   d. Criſtalline, or figured. This is very ſcarce to be met with: it has diſtinct figures, with ſhining ſurfaces; it is, however, ſometimes found at Kongſberg.

The ſilver from America is ſaid to be found for the moſt part native; ſo it is likewiſe at Kongſberg in Norway, but it is not commonly ſo in the other European mines. In Sweden it is found native in a very ſmall quantity, in the mines of Salberg in Weſtmanland, of Lofaſen in Dalarne, of Hevaſſwik and Sladkierr in the province of Dal, of Sunnerſkog in the province of Smoland, and in the Iſland Utoen in the Lake Malaren. It was once found in pretty large lumps in a vein of clay in one of the iron mines at Normark, in the province of Wermeland. It was there mixed with nickel, which was partly decayed or withered; and under this circumſtance it formed the compound ore called the *Stercus Anſerinum*, or Gooſe-dung Ore. At this place the argilla-

argillaceous vein crosses the veins of the iron ore, and will perhaps be found to have more of these riches, even in several other places, if well searched, as is done in other countries, oftentimes not on such evident marks or signs.

SECT. CLXIX.

B. Dissolved and mineralised, *Argentum mineralisatum.*

1. With sulphur alone, *Argentum sulphure mineralisatum.* Glass silver ore, *Minera argenti vitrea.*

This is ductile, and of the same colour as lead; but, however, becomes blacker in the air. It has, therefore, very undeservedly got the name of glass ore, for that name rather belongs to the *minera argenti cornea*, or horn silver ore, if indeed any silver ore can be considered as glassy.

It is found in the same manner as native gold; viz.

1. In crusts, plates, or leaves.
2. Grown into,
   - *a.* Snaggs, and,
   - *b.* Cristalline figures.

It is generally either of a lamellar or a grained texture, and is found at Kongsberg and in the Saxon mines.

The glass silver ore is the richest of all silver ores; since the sulphur, which is united with the silver in this ore, makes out but a very small quantity of its weight.

SECT. CLXX.

2. With sulphur and arsenic, *Argentum sulphure & arsenico mineralisatum. Minera argenti rubra*, The red or ruby-like silver ore. The *Rothgulden* of the Germans.

The colour of this ore varies as the proportion of each of these ingredients varies in the mixture; viz. from dark grey to deep red: but when it is rubbed or pounded, it always gives a red colour. When put in the fire, it crackles and breaks; and when the crackling ceases, it melts easily, the arsenic at the same time exhaling in smoke.

a. Grey arsenical silver ore; which is either,
   1. Plated, crusted, or leaved, and,
   2. Solid.

b. The red arsenical silver ore.
   1. Plated, crusted, or leaved.
   2. Solid or scaly, and,
   3. Cristallised.

In this last form it shews the most beautiful red colour, and is often semi-transparent. It contains about sixty per cent. in silver; and is found in the greatest quantity at Andreasberg in the Hartz.

SECT. CLXXI.

3. With sulphurated arsenic and copper, *Argentum arsenico & cupro sulphurato mineralisatum. Minera argenti albi*, The *Weissgulden* of the Germans.

This, in its solid form, is of a light grey colour, and of a dull and steel-grained tex-

ture.

ture. The more copper it contains, the darker is the colour. It often holds ſeven pounds of ſilver per cent. It is,

a. Friable, withered, or decayed, of a black or ſooty colour, and is therefore by the Germans called *Silber-Schwartz*, or *Ruſſigtes-Ertz*.

b. Solid, of a light-grey colour, and is that ſort properly ſo called Weiſſgulden.

It is found at St. Mary of the mines in Alſatia, the Saxon mines, and at St. Andreaſberg in the Hartz.

SECT. CLXXII.

4. With ſulphurated arſenic and iron, *Argentum ferro & arſenico ſulphurato mineraliſatum*, The *Weiſertz*, or white ſilver ore, of the Germans.

This is an arſenical pyrites, which contains ſilver; it occurs in the Saxon mines, and ſo exactly reſembles the common arſenical pyrites as not to be diſtinguiſhed from it by ſight alone, or without other means. The ſilver it contains may perhaps conſiſt of very ſubtile capillary ſilver mixed in it. However, I have not had an opportunity to examine this circumſtance.

SECT. CLXXIII.

5. With ſulphurated antimony, *Argentum antimonio ſulphurato mineraliſatum.*

a. Of a dark-grey and ſomewhat browniſh colour. The *Lebererz*, from Braunſdorff in Saxony.

b. Of a blackiſh blue colour.

1. In form of capillary criſtals, *Minera argenti antimonialis capillaris. Federertz*, or plumoſe ſilver ore.

It is found in Saxony, and contains only two or four ounces of ſilver per cent.

SECT. CLXXIV.

6. With ſulphurated copper and antimony, *Argentum cupro & antimonio ſulphurato mineraliſatum.* The Dal *Falertz.*

This reſembles, both in colour and texture, the dark-coloured Weiſſgulden, or Falertz. When rubbed, it gives a red powder.

a. Solid.

b. Criſtalliſed, is found in the pariſh of Aminſkog, in the province of Dal; and at that place has been for ſeveral years melted by a method invented for the different mixture of the ores; which proceſs muſt be very troubleſome to thoſe who are not perfectly well verſed in metallurgy.

It contains thirteen ounces of ſilver, and twenty-four per cent. of copper.

SECT. CLXXV.

7. With ſulphurated zink, *Argentum zinco ſulphurato mineraliſatum.* The *Pechblende* of the Germans.

This is a zink ore, mock lead, or blende, which contains ſilver, and is found among rich ſilver and gold ores; for inſtance, in the Hungarian and Saxon mines.

a. Of

a. Of a metallic changeable colour.
1. Solid, and with fine ſcales.
2. In form of balls. The *Kugel-ertz*, or ball ore.

It is found at Schemnitz, and contains alſo gold. Its yield of ſilver is twenty-four ounces per cent. and thirty per cent. of zink.

b. Black mock lead, or blende, found in Saxony. This is alſo found,
1. Solid, and with fine ſcales;
2. And in form of balls.

SECT. CLXXVI.

8. With ſulphurated lead, Potter's ore, *Galena*, *Bleyglanz*. See Sect. clxxxviii.
9. With ſulphurated lead and antimony, called *Striperz*. See Sect. cxc.
10. With ſulphurated iron, *Argentum ferro ſulphurato mineraliſatum*. *Silberhaltiger kies*, Marcaſite holding ſilver.

At Kongſberg in Norway, it is ſaid, a liver-coloured marcaſite is often found, particularly at the mine called Fraulein Chriſtiana, &c. This marcaſite contains of ſilver from three to three ounces and an half per cent.

SECT. CLXXVII.

11. With the acid of common ſalt, *Argentum acido ſalis ſolutum & mineraliſatum. Minera argenti cornea. Hornertz*, or horn ſilver ore.

This is the ſcarceſt ſilver ore; it is of a white or pearl colour, changeable or varying on the ſurface, ſemi-tranſparent, and

and ſomewhat ductile, both when crude, and when melted. It cannot be decompoſed without ſome admixture of ſuch ſubſtances as attract the acid of the ſea-ſalt. It is found in very thin worked or wrought leaves or cruſts, at Johan Georgenſtadt, in Saxony.

SECT. CLXXVIII.

OBSERVATIONS on the SILVER ORES.

Silver may, perhaps, be found mineraliſed in the like manner with other metals than theſe here enumerated, ſuch as with cobalt and biſmuth; but having no certain knowledge of ſuch mineraliſations, I omit them here. It would be worthy examining, if in thoſe mine countries where gold and ſilver are found in quantity, other ores do not contain a little of thoſe metals, more eſpecially when the particles of ſilver and gold have not been able to extricate themſelves from the other minerals, and lie ſeparate from them in the fiſſures, veins, and ſhakes or wranks, that is hollow places, in the mines.

Thoſe ſilver ores which are named from earth or ſtones, wherein the ſilver is found; as, for inſtance, in the Gooſe-dung ſilver ore, and the *Lebererts*; ought no more to be conſidered in a natural ſyſtem than other diſtinctions which are uſed at mineral works, and are only names given to the ores, according to the ſeveral changes they undergo to make them fit for the melting proceſs.

In this our time a mineraliſation of ſilver with alcali has been mentioned: it is ſaid to have been found at Annaberg in Auſtria: But this diſcovery, which is made by a mine-maſter, Mr. Von Juſti, requires an explanation, ſince the author in his deſcription does not obſerve the neceſſary diſtinction between alcali and lime; and quotes the horn ſilver ore, and the *luna cornea*, as proofs of his opinion; by which, however, his opinion ſeems rather weakened than confirmed.

SECT. CLXXIX.

3. Platina del Pinto, Platina di Pinto, *Juan blanca*.

This metal is a recent diſcovery of our times, and is deſcribed with great accuracy by Scheffer, in the Acts of the Royal Academy of Sciences at Stockholm, for the year 1752; as alſo by Dr. Lewis, in the Philoſophical Tranſactions for the year 1754, vol. xlviii. And though theſe two gentlemen agree in the principal circumſtances relating to this metal, yet it is very plain by their deſcriptions, that neither of them knew any thing of the other's experiments. By theſe deſcriptions we are convinced of the reſemblance this metal bears to gold; and therefore we muſt allow it to be called *white gold*, though, both theoretically and practically, it may be diſtinguiſhed from gold by the following qualities.

1. It is of a white colour.
2. It is ſo refractory in the fire, that there is no degree of heat yet found by which it can be brought into fuſion by itſelf, the burning-glaſs excepted, which has not yet been tried. But, when mixed with other metals, and ſemi-metals, it melts very eaſily, and eſpecially with arſenic, both in its

its metallic form, and in form of a calx or glafs.

3. It does not amalgamate with quickfilver by itfelf, but only by means of the acid of common falt after a long trituration. This metal is therefore really feparated from gold by amalgamation, at thofe places where it is found; and without this quality, it would be very difficult to feparate it.
4. It is harder and lefs coherent than gold.
5. It is heavier than gold; and therefore the heavieft of all bodies hitherto difcovered: For though the fpecific gravity of platina, in the hydroftatical experiments made by Dr. Lewis, is found to be to water only as 17,000 to 1000; yet, when melted with other certain metals, its fpecific gravity has, by an exact calculation, been found to be confiderably augmented, even fo much as to 22,000.
6. Diffolved in aqua regia, and precipitated with tin, or with a folution of that metal, it yields no *purpura mineralis*.

Except thefe, this metal has the fame qualities as gold; but it cannot, on account of its refractorinefs in the fire, be worked off pure on the cuppel, nor likewife can it be worked with antimony; becaufe, before it is rendered perfectly pure, it cools, grows hard, and retains always fome part of the added metals. It is brought to us only in its native ftate, in fmall, irregular, rugged grains; and it is yet uncertain whether it is found naturally mineralifed. The Platina is brought to

Europe from the Rio de Pinto, in the Spanish West-Indies.

SECT. CLXXX.

4. Tin, *Stannum, Jupiter.*

This is distinguished from the other metals by its following characters and qualities.

a. Of a white colour, which verges more to the blue than that of silver.

b. It is the most fusible of all metals; and,

c. The least ductile; that is, it cannot be extended or hammered out so much as the others.

d. In breaking or bending it makes a crackling noise.

e. It has a smell particular to itself, and which cannot be described.

f. In the fire it is easily calcined to white ashes, which are twenty-five per cent. heavier than the metal itself. During this operation, the phlogiston is seen to burn off in form of small sparkles among the ashes, or calx.

g. This calx is very refractory; but may, however, with a very strong degree of heat, be brought to a glass of the colour of hard resin. But this calx is easily mixed in glass compositions, and makes with them the white enamel.

h. It unites with all metals and semi-metals; but renders most of them very brittle, except lead, bismuth, and zink.

i. It amalgamates easily with quicksilver.

k. It dissolves in aqua regia, the spirit of sea-salt, and the vitriolic acid; but it is only corroded

corroded into a white powder by the ſpirit of nitre.

The vegetable acid, ſoaps, and pure alcaline ſalts, alſo corrode this metal by degrees.

l. Its ſpecific gravity to water is as 7400 to 1000, or as 7321 to 1000.

m. Diſſolved in aqua regia, which for this purpoſe ought to conſiſt of equal parts of the ſpirit of nitre and ſea-ſalt, it heightens the colour of the cochineal, and makes it deeper; for otherwiſe that dye would be violet.

SECT. CLXXXI.

Tin is not found naturally in the earth in any other ſtate than,

1. In form of a calx, *Stannum calciforme.*

A. Indurated, or vitrified, *Induratum.*

1. Mixed with a little of the calx of arſenic, *Minera ſtanni vitrea arſenicalis.*

a. Solid tin ore, without any determinate figure, Tin-ſtone.

It reſembles a garnet of a blackiſh brown colour, but is a great deal heavier; and has been conſidered at the Engliſh tin-mines as a ſtone, containing no metal, until ſome years ago it began to be ſmelted to great advantage.

b. Criſtalliſed, *Cryſtalliſatum*, Tin-grains.

Is like the garnets, of a ſpherical polygonal figure, but looks more unctuous on the ſurface.

1. In larger grains; and,
2. In ſmaller grains.

SECT. CLXXXII.

2. Tin mixed with the calx of iron. Sect. lxx.
3. Tin mixed with the manganeſe. Sect. cxvii.
4. Tin mineraliſed with ſulphur and iron, black lead. Sect. cliv.

SECT. CLXXXIII.

OBSERVATIONS on TIN.

It has indeed been aſſerted by ſome, that Tin is found native in the earth; but, for my own part, like many others, I doubt much of it, having never ſeen a ſingle ſpecimen that could be called native tin. It is, however, remarkable that tin is ſo ſcarce, and is not found in any conſiderable quantity or purity in any other places in Europe than in England and Saxony. It is likewiſe worthy obſervation, that when its ore is profitable, or to be worked to any advantage, it is always in form of an indurated calx, which anſwers to thoſe glaſſes that are prepared from metallic calces in our laboratories: Therefore, in regard to this reſemblance, as well as to what this Mineralogical Eſſay requires from its readers, I have uſed the term *calx*, in deſcribing the metals; by which word is underſtood the ſame as the chemiſts call a *crocus*, or *terra metallorum phlogiſto privata*.

The tin muſt, however, be mineraliſed with ſulphur in the black lead; but the queſtion is, whether that would have happened if the iron

had

ſhad not been preſent? This compound, or black lead, and many more, in which the iron and tin are united, are not eaſily to be examined by the common docimaſtical means: However, eaſier proceſſes may poſſibly, ſome time or other, be diſcovered, and employed for ſuch ſubſtances.

SECT. CLXXXIV.

5. Lead, *Plumbum*, *Saturnus*. It is

a. Of a blueiſh white colour when freſh broke, but ſoon dulls or ſullies in the air.

b. Is very heavy; viz. to water as 11,325 to 1000.

c. Is ſofteſt next to gold, but has no great tenacity, and is not in the leaſt ſonorous.

d. It is eaſily calcined; and, by a certain art in managing the degrees of the fire, its calx becomes white, yellow, and red.

e. This calx melts eaſier than any other metallic calx to a glaſs, which becomes of a yellow colour, and ſemi-tranſparent. This glaſs brings other bodies, and the imperfect metals, into fuſion with it.

f. It diſſolves, 1ſt, in the ſpirit of nitre; 2dly, in a diluted oil of vitriol, by way of digeſtion; 3dly, in the vegetable acid; 4thly, in alcaline ſolutions; and 5thly, in expreſſed oils, both in the form of metal and of calx.

g. It gives a ſweet taſte to all ſolutions.

h. It amalgamates with quickſilver.

i. With the ſpirit of ſea-ſalt it has the ſame effect as ſilver, whereby is produced a *ſaturnus corneus*.

k. It does not unite with iron, when it is alone added to it in the fire.

l. It works on the cuppel, which signifies that its glass enters into certain porous bodies, destitute of phlogiston, and alcaline salts.

m. It melts in the fire before it is made red-hot, almost as easily as the tin.

n. Its calx or glass may be reduced to its metallic state by pot-ashes.

SECT. CLXXXV.

Lead is found,

A. In form of a calx, *Minera plumbi calciformis.*

1. Pure, *Minera plumbi calciformis pura.*

a. Friable, lead ochre, *Cerussa nativa*, Native ceruss, is found at Kristiersberget in Westmanland, on the surface of the potter's ore.

b. Indurated, Lead spar, or spatose lead ore, *Spatum plumbi.*

1. Radiated, or fibrous.

a. White, from Mendip-Hills, in England.

2. Cristallised into a prismatical figure.

a. White, from Norrgrufva in Westmanland.

b. Yellowish green, from Zchopau in Saxony.

SECT. CLXXXVI.

2. Mixed, *Minera plumbi calciformis mixta.*

a. With the calx of arsenic, Arsenic lead-spar.

1. Indurated.

a. White. I have tried such an ore from an unknown place in Germany, and found that no metallic lead

lead could be melted from it by means of the blowpipe, as can be done out of other lead ſpars; but it muſt be performed in a crucible, and then that part of the arſenic which did not fly off in ſmoke, during the experiment, was likewiſe reduced, and found in form of grains diſperſed, and forced into the lead. Another ore of this kind, which likewiſe was not eaſily reduced by means of the blowpipe, did always after being melted, and during the cooling, haſtily ſhoot into polygonal, but moſtly hexagonal criſtals, with ſhining ſurfaces. Can this criſtalliſation be owing to ſalts, which are ſaid not to act in this manner, but when they are diſſolved in water?

b. With a calcareous earth *. See Sect. xxxvii.

* The abovementioned lead ores are very rich in lead, and eaſy to be tried; becauſe moſt of them, being ſlowly heated, may be reduced to lead by means of the blowpipe on a piece of charcoal. The calx of the lead in theſe ores has, perhaps, firſt been diſſolved by ſulphur and arſenic, and has afterwards, when theſe two have weathered away or decayed, and parted from it, aſſumed this form; in the ſame manner as we ſee it really happens during the calcination, with rich lead ores, or ſuch regules as contain lead. The ſame, very likely, is the caſe with other metals; for which reaſon their ores, when they occur in form of a calx, often contain a little ſulphur, and more eſpecially arſenic.

SECT.

SECT. CLXXXVII.

B. Mineralised, *Plumbum mineralisatum.*

1. With sulphur alone, *Plumbum sulphure mineralisatum:* The *Bley-Schweiff*, or *Bleyglanz*, of the Germans.
   - *a*. Steel-grained lead ore, from the mines at Hellefors, in the province of Westmanland.
   - *b*. Radiated, or antimoniated lead ore.
   - *c*. Tessellated, or potters lead ore.

   At Villach in Austria there is said to be found a potters lead ore, which contains not the least portion of silver.

SECT. CLXXXVIII.

2. With sulphurated silver, *Plumbum argento sulphurato mineralisatum. Galena*; also called *Bleyglanz* by the Germans.
   - *a*. Steel-grained, is found in the mines of Salberg and Hellefors, in the province of Westmanland; and in the Dorothea-mine, in the Hartz in Germany.
   - *b*. With small scales, is found at Salberg, and is there particularly called *Blyschweif*.
   - *c*. Fine-grained, found at Salberg.
   - *d*. Of a fine cubical texture; and,
   - *e*. Of coarse cubes. These two varieties are found in all the Swedish silver mines.
   - *f*. Cristallised, from Gislof in the province of Skone *.

* The steel-grained and scaly ores are of a dim and dull appearance when they are broke, and their particles have no determined angular figure: They are therefore in Swedish commonly called *Blyschweif*, in opposition to the cubical ores, which are called *Blyglanz*. But, in my opinion, the ores ought

to

SECT. CLXXXIX.

3. With ſulphurated iron and ſilver, *Plumbum ferro & argento ſulphurato mineraliſatum*, is found,

a. Fine-grained,

b. Fine cubical,

c. Coarſe cubical. Theſe are found at Weſterſilfverberget, in Weſtmanland.

When this ore is ſcorified, it yields a black ſlag; whereas the preceding lead ores yield a yellow one, becauſe they do not contain any iron.

SECT. CXC.

4. With ſulphurated antimony and ſilver, *Plumbum antimonio & argento ſulphurato mineraliſatum*. Antimoniated or radiated lead ore. This has the colour of a *Blyglanz*, but is of a radiated texture.

It is found,

a. Of fine rays or fibres, and,

b. Of coarſe rays or fibres.

And is got in Maklos Schacht and Fierde-Bottn, in the mine of Salberg in Weſtmanland. The lead in this ore prevents any uſe being made of the antimony

to be denominated and diſtinguiſhed from one another according to their metallic contents. No ore ought, by virtue of the moſt received notion, to be called *Blyſchweif*, but that which contains only lead and ſulphur. The moſt part of the ores called *Blyglanz* contain ſilver, even to twenty-four ounces per cent. of which we have inſtances in the mines of Salberg, where it has been obſerved that the coarſe cubical lead ores are generally the richeſt in ſilver, contrary to what is commonly taught in books; the reaſon of which may perhaps be, that, in making the eſſays on theſe two ores, the coarſe cubical can be choſen purer or freer from the rock, than the fine cubical ores.

timony to advantage; and the antimony likewiſe in a great meaſure hinders the extracting of the ſilver.

SECT. CXCI.

Observations on Lead Ores.

I know of no native lead; and all which has been ſaid on that ſubject is liable to remarkable reſtrictions.

Such of the potters ores as do not contain any ſilver are very ſcarce; yet they are often found ſo poor in ſilver, that it does not anſwer the expences of extracting. Theſe, when they are free from mixtures of the rock, are, without any previous fuſion, employed to glaze earthen-ware; and a great trade is carried on in the Mediterranean with ſuch ores, from the lead-mines of Sardinia and France.

SECT. CXCII.

6. Copper, *Cuprum*, *Venus*, *Æs*.

This metal is,

a. Of a red colour.

b. The ſpecific gravity of the Japan copper is 9000, and of the Swediſh 8784 or 8843, to 1000.

c. It is pretty ſoft and tough.

d. The calx of copper being diſſolved by acids becomes green, and by alcalies blue.

e. It is eaſily calcined in the fire into a blackiſh blue ſubſtance, which, when rubbed to a fine powder, is red; when melted together with glaſs, it tinges it firſt reddiſh

reddish brown, and afterwards of a transparent green or sea-green colour.

f. It dissolves in all the acids; viz. The acids of vitriol, sea-salt, nitre, and the vegetable; and likewise in all alcaline solutions. That it becomes rusty, and tarnishes in the air (a consequence of a former solution), depends very much on some vitriolic acid which is left in the copper in the refining of it. This metal is easier dissolved when in form of a calx than in a metallic state, especially by the acids of vitriol and sea-salt, and the vegetable acid.

g. Vitriol of copper is of a deep blue colour, but the vegetable acid produces with the copper a green salt, which is verdigrise.

h. It can be precipitated out of the solutions in a metallic state; and this is the origin of the precipitated copper of the mines, called Ziment copper.

i. It is not easily amalgamated with quicksilver; but requires for this purpose a very strong trituration, or the admixture of the acid of nitre.

k. It becomes yellow when mixed with zink, which has a strong attraction to it, and makes brass, pinchbeck, &c.

l. It is easily dissolved by lead glass, which last is coloured green by it.

m. When this metal is exposed to the fire, it gives a green colour to the flame in the moment it begins to melt, and continues to do so afterwards, without losing any thing considerable of its weight.

n. It requires a strong degree of heat before it melts, yet is it a lesser degree than for iron.

SECT.

SECT. CXCIII.

Copper is found in the earth,

A. Native, or in a metallic ſtate; Virgin or native copper, *Cuprum nativum.*

1. Solid, *Solidum*, is found in the iron mine of Heſslekulla, in the province of Nerike, and at Sunnerſkog, in the province of Smoland; alſo in the Ruſſian Carelia, and in other foreign places.

2. Friable, in form of ſmall, and ſomewhat coherent grains, *Cuprum nativum particulis conglomeratis diſtinctis.* Precipitated or Ziment Copper. It is found at Riddarſhyttan in Weſtmanland, at Fahlun in Dalarne, and in Hungary.

   It has been obſerved, that both copper and ſilver glaſs ore, being precipitated from water, become friable and granulated, but that they in time grow ſolid and ductile: whence the diſpute about the diſtinction between native and precipitated copper may ceaſe, the rather as native copper will ſcarcely be found in other places, and in any other kinds of ſtones, than through which the ziment or vitriolic waters have circulated; altho' the fiſſures thro' which it has run may afterwards be filled with a ſtony ſubſtance.

SECT. CXCIV.

B. In form of a calx, *Minera cupri calciformis.*

1. Pure, *Minera cupri calciformis pura.*

   a. Looſe or friable, *Ochra veneris.*

   1. Blue, *Cæruleum montanum.*

Is very ſeldom found perfectly free from a calcareous ſubſtance.

2. Green, *Viride montanum.*

Both theſe colours depend on menſtrua, which often are edulcorated or waſhed away.

3. Red. This is an efflorecence of the glaſs copper ore. It is found in the province of Dal, and at Oſtanberg, in the province of Dalarne.

SECT. CXCV.

b. Indurated, *Indurata.* Glaſs copper ore.

a. Red, *Minera cupri calciformis pura & indurata, colore rubro.*

This is ſometimes as red as ſealing-wax, and ſometimes of a more liver-brown colour. It is found in Sandbacken, at Norberg in Weſtmanland, at Ordal in Norway, in Siberia, and in Suabia in Germany.

This ore is always found along with native copper, and ſeems to have loſt its phlogiſton by way of effloreſcence, and to be changed into this form. It is likewiſe found along with the ſulphurated copper, and is commonly, though very improperly, called Glaſs copper ore.

SECT. CXCVI.

2. Mixed, *Minera cupri calciformis impura.*

a. Looſe or friable, *Ochra veneris friabilis impura.*

1. Mixed

1. Mixed with a calcareous ſubſtance, *Ochra veneris terrâ calcareâ mixta. Cæruleum montanum.* In this ſtate copper blue is moſtly found. It ferments during the ſolution in aqua fortis. See Sect. xxxiv.
2. Mixed with iron. Black. It is the decompoſition of the Fahlun copper ore. Sect. cxcviii. *a.*

b. Indurated, *Minera cupri calciformis impura indurata.*

1. Mixed with gypſum, or plaſter. Green. Is found at Ordal in Norway, and there called Malachites.
2. Mixed with quartz. Red. From Sunnerſkog, in the province of Smoland. Sect. liii. *B.*
3. Mixed with lime. Blue. This is the *lapis armenus*, according to the accounts given of it by authors.

SECT. CXCVII.

C. Diſſolved and mineraliſed, *Cuprum mineraliſatum.*

1. With ſulphur alone, *Cuprum ſulphure mineraliſatum.* Grey copper ore. Is improperly alſo called Glaſs copper ore.

a. Solid, without any certain texture, *Minera cupri ſulphurata ſolida texturâ indeterminatâ.* This is very ſoft, ſo that it can be cut with a knife, almoſt as eaſily as black lead.

b. Fine cubical, *Minera cupri ſulphurata teſſulis conſtans minoribus.*

Both theſe varieties are found at Sunnerſkog, in Smoland; where the laſt is ſometimes

ſometimes found decompoſed or weathered, and changed into a deep mountain blue. Sect. cxciv.

SECT. CXCVIII.

2. With ſulphurated iron, *Minera cupri pyritacea:* Yellow copper ore. Marcaſitical copper ore, *Pyrites cupri.*

This is various both in regard to colour, and in regard to the different proportion of each of the contained metals; for inſtance:

a. Blackiſh grey, inclining a little to yellow, *Pyrites cupri griſeus.*

When decayed or weathered, it is of a black colour; is the richeſt of all the varieties of this kind of copper ore, yielding between 50 and 60 per cent. and is found in Spain and Germany.

b. Reddiſh yellow, or liver brown, with a blue coat on the ſurface, *Minera cupri lazurea.*

This ore yields between 40 and 50 per cent. of copper, and is commonly ſaid to be blue, though it is as red when freſh broke, as a rich copper regulus.

c. Yellowiſh green, *Pyrites cupri flavo viridescens.*

This is the moſt common in the north part of Europe; and is, in regard to its texture, found

1. Solid, and of a ſhining texture, from Oſtanberg, in the province of Dalarne.
2. Steel-grained, of a dim texture, from the ſame place, and Falun in Dalarne.
3. Coarſe-grained, is of an uneven and ſhining texture. It occurs in moſt of

 the

the Swediſh and Norwegian copper mines.

4. Criſtalliſed marcaſitical copper ore.

a. Of long octoëdrical criſtals.

This is found at Hevaſſwik, in the province of Dal, and in Loviſagrufva, in Weſtmanland; notwithſtanding its exiſtence is denied by Henckel, and his followers.

d. Pale yellow, *Pyrites cupri pallidè flavus.*

This cannot be deſcribed but as a marcaſite, though an experienced eye will eaſily diſcover ſome difference between them. It is found at Tunaberg, in the province of Sodermanland, and yields 22 per cent. of copper.

e. Liver-coloured.

This is found at Falun, in Dalarne, where it contains copper; though at moſt other places, where it occurs, it does not contain any copper, but is only a martial marcaſite.

SECT. CXCIX.

3. With ſulphurated arſenic and iron, *Cuprum ferro ex arſenico ſulphurato mineraliſatum.* White copper ore.

It is ſaid to be found in the Hartz, in Germany, and to reſemble an arſenical pyrites; but I have never met with this kind.

However, moſt of the pyritical copper ores, as well as the marcaſites, contain a little arſenic, though it is in too ſmall a quantity to be obſervable.

SECT. CC.

4. Diſſolved by the vitriolic acid, *Cuprum acido vitrioli ſolutum : Vitriolum Veneris.* See Sect. cxxii.
5. With phlogiſton. Copper coal ore. See Sect. clxi.

SECT. CCI.

7. Iron, *Ferrum, Mars.* It is
   - *a.* Of a blackiſh blue ſhining colour.
   - *b.* It becomes ductile by repeated heating between coals, and hammering.
   - *c.* It is attracted by the loadſtone, which is an iron ore; and the metal itſelf may alſo be rendered magnetical.
   - *d.* Its ſpecific gravity to water is as 7,645, or 8000 : : 1000.
   - *e.* It calcines eaſily to a black ſcaly calx, which, when pounded, is of a deep red colour.
   - *f.* When this calx is melted in great quantity with glaſs compoſitions, it gives a blackiſh brown colour to the glaſs; but in a ſmall quantity a greeniſh colour, which at laſt vaniſhes, if forced by a ſtrong degree of heat.
   - *g.* It is diſſolved by all ſalts, by water, and likewiſe by their vapours. The calx of iron is diſſolved by the ſpirit of ſea-ſalt, and by aqua regia.
   - *h.* The calx of the diſſolved metal becomes yellow, or yellowiſh brown; and in a certain degree of heat, it turns red.

i. The ſame calx, when precipitated from acids, by means of the fixed alcali, is of a greeniſh colour; but it becomes blue, when precipitated by means of an alcali united with phlogiſton, in which laſt circumſtance the phlogiſton unites with the iron: Theſe two precipitates loſe their colour in the fire, and turn brown.

k. The vitriol of iron is green.

l. It is the moſt common metal in nature, and at the ſame time the moſt uſeful in common life; notwithſtanding which, its qualities are perhaps very little known.

SECT. CCII.

Iron is found,

A. In form of calx, *Minera ferri calciformis pura*.

1. Pure.

a. Looſe and friable, *Minera ferri calciformis pura friabilis*. Martial ochre, *Minera ochracea*.

1. Powdry, *Ochra ferri*, is commonly yellow or red, and is iron which has been diſſolved by the vitriolic acid.

2. Concreted. Bog-ore.

a. In form of round porous balls.

b. More ſolid balls.

c. In ſmall flat pieces, like cakes, or pieces of money.

d. In ſmall grains.

e. In lumps of an indeterminate figure.

All theſe are of a blackiſh brown, or a light brown colour. They are found in lakes in the province of Smoland;

Smoland; and in marſhes at Fiell-ryggen, a chain of rocks which ſeparates Sweden from Norway.

SECT. CCIII.

b. Indurated, *Minera ferri calciformis pura indurata.* The bloodſtone, *Hæmatites.*

1. Of an iron colour, *Hæmatites cæruleſcens.*

This is of a blueiſh grey colour; it is not attracted by the loadſtone, yields a red powder when rubbed, and is hard.

a. Solid, and of a dim appearance when broken.

b. Cubical, and of a ſhining appearance when broken.

c. Fibrous, is the moſt common *Torrſten* of Sweden.

d. Scaly; the *Eiſenman* of the Germans.

This is for the moſt part as if it were micaceous, though the ſcales go acroſs the ſtrata of the ſtone. It is found at Jobſbo, in Norrberne in Dalarne, and Reka Klitt, in the province of Helſingland.

1. Black, from Gellebeck, in Norway.

2. Blueiſh grey, from Reka Klitt.

When this is found along with marcaſite, as at Sandſwar, in Norway, it is not only attracted by the loadſtone, but is of itſelf really a loadſtone. Sect. ccxi.

c. Criſtalliſed.
1. In octoëdrical criſtals.
2. In polyëdrical criſtals.
3. In a cellular form, from Moſsgrufvan, at Norberg in Weſtmanland.

These varieties are the moſt common in Sweden, and are very ſeldom blended with marcaſite, or any other heterogeneous ſubſtance, except their different beds. It is remarkable, that, when theſe ores are found along with marcaſite, thoſe particles, which have laid neareſt to the marcaſite, are attracted by the loadſtone, although they yield a red or reddiſh brown powder, like thoſe which are not attracted by the loadſtone: It is likewiſe worth obſervation, that they generally contain a little ſulphur, if they are inbedded in a lime-ſtone rock, which however very ſeldom happens in Sweden; but I know only one ſuch inſtance, viz. at Billſio, in Soderberke, in the province of Dalarne. Sect. ccxiii.

SECT. CCIV.

2. Blackiſh brown bloodſtone, *Hæmatites nigreſcens*. Kidney ore.

This yields a red or brown powder when it is rubbed; it is very hard, and is attracted by the loadſtone.

a. Solid, with a glaſſy texture, from Weſterſilfverberget, in the province of Weſtmanland.

b. Radiated.

c. Criſtalliſed.

1. In form of cones, from Siberia.
2. In form of concentrick balls, with a facetted ſurface.

These are very common in Germany, but very ſcarce in Sweden.

SECT. CCV.

3. Red bloodſtone, *Hæmatites ruber*. Red kidney ore.
a. Solid, and dim in its texture, from Weſterſilfverberget, in Weſtmanland.
b. Scaly. The *Eiſenman* of the Germans. This is commonly found along with the iron-coloured iron glimmer, (Sect. cciii. 1. *d*.) and ſmears the hands.
c. Criſtalliſed.
1. In concentrick balls, with a flat or facetted ſurface.

SECT. CCVI.

4. Yellow bloodſtone, *Hæmatites flavus*.
a. Solid.
b. Fibrous, from Lammerhof, in Bohemia *.

SECT. CCVII.

2. Iron in form of calx, mixed with heterogeneous ſubſtances, *Minera ferri calciformis heterogeneis mixta*. *a*. With

* The varieties of the colours in the bloodſtone are the ſame with thoſe produced in the calces of iron, made by dry or liquid menſtrua, and afterwards expoſed to different degrees of heat.

a. With a calcareous earth, White ſpathoſe iron ore. The *Stahlſtein* of the Germans. See Sect. xxx.

b. With a ſiliceous earth. The Martial Jaſper or Sinople. Sect. lxv.

c. With a garnet earth. Garnet and cockle or ſhirl. Sect. lxix.

d. With an argillaceous earth. The bole. Sect. lxxxvi.

e. With a micaceous earth. Mica. Sect. xcv.

f. With manganeſe. Sect. cxvi.

SECT. CCVIII.

g. With an alcali and phlogiſton, *Calx martialis phlogiſto juncta, et alcali precipitata.* Blue martial earth. Native Pruſſian-like blue.

1. Looſe or powdry, found among the turf in the levels of the province of Skone: Alſo in Sax Weiſſenfels, and at Norvlanden in Norway, &c.

SECT. CCIX.

h. With an unknown earth, which hardens in water, *Calx martis terrâ incognitâ aquâ indureſcente mixta.* Tarras, *Cementum.*

1. Looſe or granulated, *Terra Puzzolana,* from Naples and Civita Vecchia in Italy. This is of a reddiſh brown colour, is rich in iron, and is pretty fuſible.
2. Indurated, *Cementum induratum,* from Cologne.

This

This is of a whitiſh yellow colour, contains likewiſe a great deal of iron, and has the ſame quality with the former, to harden ſoon in water, when mixed with mortar. This quality cannot be owing to the iron alone, but rather to ſome particular modification of it, occaſioned by ſome accidental cauſes, becauſe theſe varieties rarely happen at any other places, except where volcanos have been, or are yet in the neighbourhood.

SECT. CCX.

1. Calx of iron, united with another unknown earth, *Ferrum calciforme terrâ quâdam incognitâ intimè mixtum.* The *Tungſten* of the Swedes.

This is alſo, though improperly, called White Tingrains. Sect. clxxxi.

This reſembles the garnet-ſtone, (Sect. lxix.) and the tin-grains; is nearly as heavy as pure tin; very refractory in the fire, and exceſſively difficult to reduce to metal. Iron has, however, been melted out of it to more than 30 per cent. It is very difficultly diſſolved by borax and alcaline ſalts, but melts very eaſily with the microcoſmic ſalt, giving a black ſlag: And for this reaſon, this laſt mentioned ſalt muſt be employed in the experiments on this ſtone. It is found,

1 Solid and fine-grained.

a. Reddiſh or fleſh-coloured.

b. Yellow.

b. Yellow, from Baſtnaſgrufva at Riddarſhyttan in the province of Weſtmanland.

2. Spathoſe, and with an unctuous ſurface.

a. White, from Marienberg and Altenberg, in Saxony.

b. Pearl-coloured, from Biſpberg Klack, in the province of Dalarne *.

SECT. CCXI.

B. Diſſolved or mineraliſed iron, *Ferrum mineraliſatum.*

1. With ſulphur alone.

a. Perfectly ſaturated with ſulphur, *Ferrum ſulphure ſaturatum.* Marcaſite. See Sulphur, Sect. clii.

b. With very little ſulphur. Black iron ore. Iron ſtone. *Minera ferri atra.*

This is either attracted by the loadſtone, or is a loadſtone itſelf, attracting iron; it reſembles iron, and yields a black powder when rubbed.

1. Magnetic iron ore, *Minera ferri attractoria.* The Loadſtone, *Magnes.*

a. Steel-grained, of a dim texture, from Hogberget, in the pariſh of Gagnœf

* This kind of ſtone is very ſeldom met with, but in ſuch places where black lead is common in the neighbourhood; and the hiſtory of the black lead, inſerted in the Memoirs of the Swediſh Academy of Sciences, has induced me to believe, that this may contain ſome tin, which merits further examination. Mr. Cronſtedt has in the ſaid Memoirs communicated his experiments upon this kind of ſtone from Riddarſhyttan, and Biſpberget in Weſtmanland; as has alſo Mr. Rinman, on a great number of other martial earths. See the ſaid Memoirs for the years 1751 and 1754.

Gagnœf in Dalarne: It is found at that place almoſt to the day, and is of as great ſtrength as any natural loadſtones were ever commonly found.

b. Fine-grained, from Saxony.

c. Coarſe-grained, from Spetalsgrufvan, at Norberg, and Kierrgrufvan, both in the province of Weſtmanland. This loſes very ſoon its magnetical virtue.

d. With coarſe ſcales, found at Sandſwœr in Norway. This is a pyritical *Eiſenman*, and yields a red powder when rubbed. Sect. cciii.

SECT. CCXII.

2. Refractory iron ore, *Minera ferri refractoria*. This in its crude ſtate is attracted by the loadſtone.

a. Giving a black powder when rubbed, *Tritura atra*. Of this kind are,

1. Steel-grained, from Adelfors, in the province of Smoland.
2. Fine-grained, from Dannemora, in the province of Upland.
3. Coarſe-grained, from Kierrgrufvan, in the province of Weſtmanland.

This kind is found in great quantities in all the Swediſh iron mines; and of this moſt part of the fuſible ores conſiſt, becauſe it is commonly found in ſuch kinds of rocks as are very fuſible: And

And it is as ſeldom met with in quartz, as the hæmatites is met with in limeſtone.

SECT. CCXIII.

b. Rubbing into a red powder, *Tritura rubra.*

These are real hæmatites, that are ſo far modified by ſulphur or lime, as to be attracted by the loadſtone.

1. Steel-grained, found in a deſerted mine at Billſio, in the pariſh of Soderberke in Dalarne.
2. Fine-grained. Emery. This is imported from the Levant: It is mixed with mica, is ſtrongly attracted by the loadſtone, and ſmells of ſulphur when put to the fire.
3. Of large ſhining cubes, from Thomiensgrube at Arendal in Norway.
4. Coarſe, ſcaly. The *Eiſenglimmer* or *Eiſenman* from Gellebeck in Norway *.

SECT. CCIV.

2. With arſenic, *Ferrum arſenico mineraliſatum.* Called Miſpickel by the Germans, and Plate Mundic in Cornwall.
3. With ſulphurated arſenic. (Sect. ccxliii.) Arſenical Pyrites.

* Theſe are very ſcarce in Sweden, moſt part of the Swediſh bloodſtones being pure, as has already (Sect. cciii.) been ſaid, and form that very profitable ore in Swediſh called *Torrſten.*

4. With vitriolic acid. Martial vitriol. Sect. cxxii.
5. With phlogiston. Martial coal ore. Sect. clxi.
6. With other sulphurated and arsenicated metals. See these in their respective arrangements.

SECT. CCXV.

Observations on Iron.

This metal enters into so many compositions, that they cannot all be possibly enumerated; it must therefore suffice to mention only those, in which it makes out the predominant part. This metal is found in animals and vegetables; and certain iron ores seem to be of service to the vegetable kingdom, as is manifestly seen on the ground round, and under the heaps of loose stones laid up in separating the ore from the rock, at those iron mines, where the ores are mixed with limestone.

With respect to œconomical effects, iron is divided into cold-short, red-short, and tough; and the ores into refractory, fusible, and those that do not want any admixture; which depends on accidental circumstances, and the method of working.

Although iron is commonly mixed in the different kinds of earth, yet it cannot be asserted with Becher, that iron may be melted out of every earth, by adding only a phlogiston; since in that case this metal might also be got out of Muscovy glass, pure quartz, chalk, white transparent fluor, &c. which very likely has never yet been done.

Nature has bestowed on Sweden an immense store of iron ores; so that whole mountains, in Tornea and Lappmark in Lapland, consist solely of of a pure, and a very rich iron ore: Large veins of the ſame ore are likewiſe found in almoſt every province of that kingdom of ſuch a nature, that few countries can produce better or richer.

The magnetical power, with reſpect to its principles and origin, is no better underſtood than electricity, yet ſomewhat more with reſpect to its effects. Though both theſe qualities are now conſidered as different powers, they may perhaps in time be regarded as ſomething nearer allied to each other.

The magnetical power is not innate in the iron, but is collected into it by degrees, which is verified by experiments; it may be expelled, it may vaniſh and gather again, as it were out of the air, ſince the natural loadſtones for the moſt part occur in ſmall veins to the day, whilſt deeper, only refractory iron ores are found. There is the ſame difference between an artificial magnet of Dr. Knight's, and a bar of ſteel, whether of the ſame ſhape or not, as between a natural loadſtone, and a blackiſh blue iron ore; whence it is ridiculous to inſiſt with a certain author, that no iron ore can be attracted by the loadſtone, but what of itſelf contains ſome magnetical virtue.

SECT. CCXVI.

The SECOND ORDER.

SEMI-METALS.

There are but ſeven ſemi-metals yet diſcovered. viz.

1. Quickſilver, Mercury, *Argentum vivum*, *Mercurius*, *Hydrargyrum*.

This diſtinguiſhes itſelf from all metals, by the following qualities. *a.* Its *a.* Its colour is white and ſhining, a little darker than that of ſilver.

b. It is fluid in the cold, and diviſible by the leaſt force; but, as it only ſticks to a few bodies, to which it has an attraction, it is ſaid that it does not wet.

c. It is volatile in the fire.

d. Its weight is next to that of the gold, viz. to water, as 13,593 : : 1000.

e. It attracts the other ſemi-metals and metals, and unites with them all, except cobalt and nickel, with which it cannot by any means yet known be made to mix. This union is called an amalgamation. This amalgamation, or mixtion of metallic bodies, according to the readineſs with which they unite or mix, is in the following progreſſion, viz. gold, ſilver, lead, tin, zink, biſmuth, copper, iron, and the regulus of antimony: But the three latter however do not very readily amalgamate. The iron requires a ſolution of the vitriol of iron, as a medium to promote the union.

f. It diſſolves in the ſpirit of nitre, out of which it is precipitated by a volatile alcali, and the common ſalt, in form of a white powder; but if a fixed alcali is uſed, into a yellow powder or calx.

g. It diſſolves in the oil of vitriol by a ſtrong boiling.

h. It is not affected by the acid of common ſalt, unleſs it be previouſly diſſolved by other acids; in which caſe only they unite with one another, and may be ſublimed together, the which ſublimation is a ſtrong poiſon.

i. It

i. It unites with ſulphur by grinding, and then produces a black powder, called *æthiops mineralis*, which ſublimes into a red ſtriated body, called factitious cinnabar.

k. The ſulphur is again ſeparated from the quickſilver, by adding iron or lime, to which the ſulphur attaches itſelf, leaving the quickſilver to be diſtilled over in a metallic form; but if a fixed alcali is added to it, ſome part of the quickſilver will remain in the reſiduum, and in that caſe makes a liver of ſulphur.

SECT. CCXVII.

Quickſilver is found,

A. Native, or in a metallic ſtate, *Mercurius nativus*, *virgineus*.

This is found in the quickſilver mines at Idria in Friuli, or the Lower Auſtria, in clay, or in a black ſlaty lapis ollaris, out of which it runs, either ſpontaneouſly, or by being warmed even in the hands. It has ſeveral times been found at Herr Sten's Bottn, in the mines of Salberg, in Weſtmanland, and ſometimes alſo amalgamated with native ſilver.

SECT. CCXVIII.

B. Mineraliſed, *Mercurius mineraliſatus*.

1. With ſulphur, *Mercurius ſulphure mineraliſatus*. Cinnabar, *Cinnabaris nativa*.

This is of a red colour, and its ſpecific gravity to water is as 7500 : : 1000.

a. Looſe or friable cinnabar, *Cinnabaris friabilis*, looks like red ochre.

It is found in the duchy of Zweybruck or Deuxponts, in Germany.

b. Indurated, *Minera Mercurii indurata*; Solid cinnabar. Is of a deep red colour, and, with respect to its texture, is either,

1. Steel-grained, from Siebenburgen;
2. Radiated;
3. Composed of small cubes, or scaly, from Idria and Hungary; or
4. Cristallised,
   a. In a cubical form; it is transparent, and deep red as a ruby, from Muschlansberg in Zweybruck *.

SECT. CCXIX.

2. Mineralised with sulphur and copper, *Mercurius cupro sulphurato mineralisatus.* This is blackish grey, of a glassy texture, and brittle; crackles and splits excessively in the fire; and when the quicksilver and sulphur are evaporated, the copper is discovered by its common opaque red colour in the glass of borax, which, when farther forced in the fire, or diluted, becomes green and transparent. It is found at Muschlansberg in Zweybruck.

SECT. CCXX.

Observations on Quicksilver.

The divisibility of quicksilver in the cold, might occasion some doubt, whether it really deserves to be called a metal, if it had not a right to it from

* It is said, that there is also found in Idria a black cinnabar, that retains its colour in the sublimation, which seems to indicate an abundant phlogiston in the sulphur; but this requires, however, a farther examination.

the earlieſt times, being then reckoned among the metals, when even they were named after the planets, the number of both being thought equal.

The opinion, which has a long time prevailed, that the quickſilver is a neceſſary ingredient, and conſtituent part in all metals, is not ſo generally received now as heretofore; ſince thoſe proceſſes, which have been advanced as proofs of it, and which have, however, but ſeldom been repeated, do by no means ſucceed, at leaſt not in all places; it is rather ſuppoſed, that by the mercurial earth the ancients have underſtood an earth, which may, by addition of phlogiſton, be reduced in the fire to a metallic ſtate; and this appears to be ſo much the more reaſonable, as the quickſilver only attracts the metals in their ſubſtances, and not in their burnt calces.

SECT. CCXXI.

2. Biſmuth, Tinglaſs, *Viſmutum*, *Biſmutum*, *Marcaſita officinalis*. It is

a. Of a whitiſh yellow colour.

b. Of a laminated texture, ſoft under the hammer, and nevertheleſs very brittle.

c. Its ſpecific gravity to water is, as 9,700 : : 1000.

d. It is very fuſible, calcines and ſcorifies like lead, if not rather eaſier, and therefore it works on the cuppel. It is pretty volatile in the fire.

e. Its glaſs or ſlag becomes yellowiſh brown, and has the quality of retaining ſome part of the gold, if that metal has been melted, calcined, and vitrified with it.

f. It may be mixed with the other metals, except cobalt and zink, making them white and brittle.

g. It

g. It diſſolves in aqua-fortis, without imparting to it any colour; but to the aqua-regia it gives a red colour, and may be precipitated out of both theſe ſolutions with pure water, into a white powder, which is called *Spaniſh white*. It is alſo precipitated by the acid of ſea-ſalt, which laſt unites with it, and makes the *Viſmutum corneum*.

h. It amalgamates eaſily with quickſilver. Other metals are ſo far attenuated by the biſmuth, when mixed with it, as to be ſtrained or forced along with the quickſilver through ſkins or leather.

SECT. CCXXII.

Biſmuth is found in the earth.

A. Native, *Viſmutum nativum*.

This reſembles a regulus of biſmuth, but conſiſts of ſmaller ſcales or plates.

1. Superficial, or in cruſts.
2. Solid, and compoſed of ſmall cubes.

This is found in, and with, the cobalt ore, at Schneeberg in Saxony, and other foreign places: Likewiſe along with the copper ore, at Nyberget, in the pariſh of Stora Skedwi, in the province of Dalarne.

SECT. CCXXIII.

B. In form of calx, *Viſmutum calciforme*.

1. Powdry or friable, *Ochra viſmuti*.

This is of a whitiſh yellow colour; it is found in form of an efflorescence, to the day, at Los, in the province of Helſingland.

It has been cuſtomary to give the name of Flowers of Biſmuth to the pale red calx of cobalt, but it is wrong; becauſe neither the calx of biſmuth, nor its ſolutions, become red, this being a quality belonging to the cobalt.

I have ſeen a radiated criſtalliſation of a metallic appearance, which was found at Schneeberg, and was likewiſe called Biſmuth Flowers; but in the ſmall trial I was permitted to make on it, it did not diſcover the leaſt marks of biſmuth, but anſwered rather to zink, if zink may be ſuppoſed to exiſt in a native ſtate.

SECT. CCXXIV.

C. Mineraliſed biſmuth, *Viſmutum mineraliſatum.*

This is, with reſpect to colour and appearance, like the coarſe teſſellated potter's lead ore; but it conſiſts of very thin ſquare plates or flakes, from which it receives a radiated appearance, when broken croſswiſe.

1. With ſulphur, *Viſmutum ſulphure mineraliſatum.*
   - *a.* With large plates or flakes, from Baſtnas at Riddarſhyttan, Baſringe and Stripas in Weſtmanland.
   - *b.* With fine or ſmall ſcales, from Jacobsgrufvan at Riddarſhyttan, and the mines at Los, in the pariſh of Farila, in Helſingland.

SECT. CCXXV.

2. With ſulphurated iron, *Viſmutum ferro ſulphurato mineraliſatum.*

a. Of

a. Of coarſe, wedge-like ſcales, from Kongruben, at Gellebeck in Norway *.

SECT. CCXXVI.

Observations on Bismuth.

Although Mr. Pott has, in a ſeparate treatiſe on biſmuth, ſhewn, that it is diſſolved without giving any colour to the ſolution, and that it is precipitated with pure water; and, though the mine-maſter Mr. Brandt has likewiſe, in the *Acta Upſalienſia* for the year 1735, given an accurate hiſtory of the cobalt, we find nevertheleſs in ſome new authors ſuch a definition of biſmuth, as includes at the ſame time the principal characters of the cobalt, viz that of giving to glaſs a blue colour, and to tinge ſolutions red. This confuſion proceeds from the biſmuth being commonly found among cobalt ores, and that it cannot be ſeparated from it but by the way of eliquation; during which the cobalt, as being leſs fuſible, remains, and is by the workmen called *Viſmut graupe*, or Biſmuth grains.

This error is excuſable in thoſe who do not pretend to maintain and vindicate their ignorance, it having been the fate of the ſemi-metals to be but very little examined. If the alchemiſts had not thought the quickſilver, antimony, and zink, fit for their purpoſes, we ſhould very likely have ſtill wanted many of thoſe advantages which they af-

* This mineraliſed biſmuth ore yields a fine radiated regulus; for which reaſon it has been ranked among the antimonial ores, by thoſe who have not taken proper care to melt a pure regulus or deſtitute of ſulphur from it; while others, who make no difference between regules and pure metals, have ſtill more poſitively aſſerted it to be only an antimonial ore.

ford both in medicine and common life. The bismuth, it is true, has likewise in its time been in some favour with adepts; but it soon lost its credit, and was left to those who contented themselves with less prospects than of making gold and the universal medicine; as to pewterers, tin-workers, and other tradesmen, who find their advantage in the fusibility of this semi-metal, and its giving colour and hardness to tin and lead.

SECT. CCXXVII.

3. Zink, Speltre, *Zincum*.

a. Its colour comes nearest to that of lead, but it does not so easily tarnish.

b. It shews a texture, when it is, broken, as if it were compounded of flat pyramids.

c. Its specific gravity to water is, as 6,900 or 7000 : : 1000.

d. It melts in the fire before it has acquired a glowing heat; but when it has gained that degree of heat, it burns with a flame of a changeable colour, between blue and yellow; and if in an open fire, the calx rises in form of soft white flowers; but if in a covered vessel, with the addition of some inflammable, it is distilled in a metallic form; in which operation, however, part of it is sometimes found vitrified.

e. It unites with all the metals, except bismuth, and makes them volatile. It is however not easy to unite it with iron without the addition of sulphur. It has the strongest attraction to gold and copper, and this last metal acquires a yellow colour by it; which has occasioned many experi-

ments

ments to be made to produce new metallic compofitions.

f. It is diffolved by all the acids; of thefe the vitriolic acid has the ftrongeft attraction to it, yet it does not diffolve it, if it is not previoufly diluted with much water. The abundance of phlogifton in this femi-metal is perhaps the reafon of its ftrong attraction to the vitriolic acid.

g. Quickfilver amalgamates eafier with zink than with copper, by which means it is feparated from compofitions made with copper.

h. It feems to become electrical by friction, and then its fmaller particles are attracted by the loadftone; which effects are not yet perfectly inveftigated; but they may excite philofophers to make farther experiments, in order to difcover whether the electrical power fhews itfelf in the metals, by being attracted by the loadftone, or whether the magnetic power can be exerted on other metals than iron.

SECT. CCXXVIII.

Zink is found,

A. In form of calx, *Zincum calciforme naturale.*

1. Pure, *Minera zinci calciformis pura.*

a. Indurated, *Indurata.*

1. Solid.

2. Criftallifed.

This is of a whitifh grey colour, and its external appearance is like that of a lead fpar; it cannot be defcribed, but is eafily known by an experienced eye. It looks very like an artificial glaſs of zink, and is found among other calamines at Namur, and in England.

2. Mixed, *Minera zinci calciformis impura.*

a. With a martial ochre, *Ochra ſive calx zinci martialis.*

1. Half indurated, *Ochra zinci indurata.* Calamine, *Lapis calaminaris.*

a. Whitiſh yellow, from Tarnovitz, in Sileſia, England, and Aix-la-Chapelle.

b. Reddiſh brown, Poland and Namur. This ſeems to be a mouldered or weathered blende.

b. With a martial clay or bole, from Hollberget in Norberke, in Weſtmanland. Sect. lxxxvi. *d.*

c. With a lead ochre and iron, England.

SECT. CCXXIX.

B. Mineraliſed zink, *Zincum mineraliſatum.*

1. With ſulphurated iron, *Zincum ferro ſulphurato mineraliſatum.* Blende, Mocklead, Black jack, Mock ore, *Pſeudogalena* and *Blende* of the Germans.

a. Mineraliſed zink in a metallic form, *Zincum formâ metallicâ ſulphuratum.* Zink ore.

This is of a metallic blueiſh grey colour, neither perfectly clear as a potter's ore, nor ſo dark as the Swediſh iron ores.

1. Of a fine cubical or ſcaly texture, from China, Kongſberg, and Jarlsberg in Norway.

2. Steel-

2. Steel-grained, from Bowallen and Skienſhyttan, in the pariſh of Tuna, in Dalarne.

SECT. CCXXX.

b. In form of calx, *Zincum calciforme cum ferro ſulphuratum*; Blende. Mocklead, *Sterile nigrum*. *Pſeudogalena*. This is found,

1. With coarſe ſcales,
   a. Yellow, ſemi-tranſparent, from Scharffenberg in Miſnia, Schemnitz and Kongſberg.
   b. Greeniſh, from Kongſberg.
   c. Black, *Pechblende* or *Pitch Blende* of the Germans, from Salberg and Falun in Sweden, and from Saxony.
   d. Blackiſh brown, from Storfallſberget in Tuna in Dalarne.
2. With fine ſcales,
   a. White, from Silfberget in the pariſh of Rettwik in Dalarne,
   b. Whitiſh yellow, from Rettwik.
   c. Reddiſh brown, from Salberg, Silfverberget, and Hellefors in Weſtmanland.
3. Fine and ſparkling; at Goſlar called *Braun Bleyertz*.
   a. Dark Brown, from the Rammelsberg in the Hartz, and Salberg in Weſtmanland *.

SECT.

* The zink, in theſe laſt kinds of blendes, is as it were in form of a calx or glaſs, ſo that they are often tranſparent; On the contrary, in the zink ore, (Sect. ccxxix. *a.*) it ſeems rather to be in a metallic form, or like moſt other metals, mineraliſed

SECT. CCXXXI.

Observations on Zink.

It does not ſeem juſt to conclude from old coins and other antiquities, that it is evidently proved that the making of braſs was known in the moſt antient times, and that it was their *Æs Corinthia-*

neraliſed with ſulphur. The ſulphur, nevertheleſs, exiſts in the different kinds of blende, equally as in the zink ore; and this remarkable difference in their appearance muſt be accounted for from another principle than the quantity of the zink which they contain; becauſe the yellow and white blendes are often found richer than the zink ores, but the zink ores are however more eaſy to melt, and conſequently more profitable. Perhaps it is becauſe the blende does not contain a ſufficient quantity of the phlogiſton of the ſulphur, to prevent the calcination of the zink.

It is no matter whether a calcined blende is called calamine or not, provided it has ſuch properties that it may be employed to the ſame purpoſes. and with the ſame advantage as that calamine which nature has freed from its ſulphur by its weathering or decaying. This may be done with ſome kinds of blende, and Mr. Von Swab has given evident and excellent proofs of it in Sweden; inſomuch that it would demonſtrate a want of experience to inſiſt that ſulphur cannot be expelled by calcination, without deſtroying the zink itſelf, and that flowers of zink may be produced from zink ores in a calcining heat, without addition of any phlogiſton.

Mr. Juſti however avers, that he has found an ore of this quality, which in his Mineralogy he calls *Zinkſpat*; but there is great reaſon to doubt if it really contains any zink, until it is proved whether the author added any phlogiſton during the calcination, or reduced the zink out of it; becauſe, although the flowers of zink may not always be perfectly well calcined, yet there is no inſtance of a natural zink ore being diſcovered, which by itſelf yields thoſe flowers during the calcination: And it requires, beſides, a ſtrong heat to produce theſe flowers from a perfect calx or glaſs of this ſemi-metal, either natural or artificial, though mixed with a phlogiſton; for it could not have been a native zink, ſince it reſembled a ſpar, and ſuch a one very likely is not to be found in nature.

cum

cum which contained copper and zink: But, however, it is not long ſince this ſemi-metal was diſcovered to lie concealed in calamine, and that calamine was its particular ore, and alſo a body of diſtinct qualities, prepared by nature, equal to that which is got tolerably pure at the furnaces of Goſllar, or that is imported from China, under the name of *Tutanague*. Mr. Brandt removed a great many doubts about the origin of zink, and the metallic earth of the calamine, by having, in the year 1734, a favourable opportunity of examining the calamines, and different kinds of blendes, from Rettwik in the province of Dalarne. He then proved, in his hiſtory of the ſemi-metals, that blendes and calamines are ores of zink, and that the clear alum-like vitriol, called *Galitzenſtein* by the Germans, (Sect. cxxii.) was its vitriol. Soon after, the blueiſh grey zink ore was diſcovered by Mr. Von Swab at Bowallen, who in the year 1738 prepared calamine from it, and erected a work for diſtilling zink at large from it, at Weſterwiken in Dalarne; which manufacture, however, afterwards was laid aſide for other intervening buſineſs. Thus theſe firſt diſcoverers might perhaps have given Meſſieurs Pott and Margraff the opportunity to write the hiſtory of zink, then more known to the world; the former in his Treatiſe *De Pſeudogalenâ*, in the year 1741; and the latter in the Memoirs of the Academy of Berlin; though this notice is by no means intended to prejudice theſe ingenious gentlemen of the honour they merit, to have of themſelves had the ſame opinion, and purpoſed the ſame experiments.

The zink ore from Ramelſberg in the Hartz, is, like moſt of the lead and copper ores from the ſame mines, of a very fine-grained texture; and it is likewiſe ſo often equally mixed with the ſaid copper and lead ores, as not to be eaſily perceived, if one is not previouſly acquainted with them. It ſeems, nevertheleſs, reaſonable, that a true mineraliſt ought rather to ſuſpect the ore called *Braunbleyertz* (Sect. ccxxx.) to be a zink ore, than to ſuppoſe this ſemi-metal to be a product of lead, copper, and iron.

SECT. CCXXXII.

4. Antimony, *Antimonium. Stibium.* This ſemi-metal is

a. Of a white colour almoſt like ſilver.

b. Brittle; and in regard to its texture, it conſiſts of ſhining planes, of greater length than breadth.

c. In the fire it is volatile, and volatiliſes part of the other metals along with it, except gold and platina. It may, however, in a moderate fire be calcined into a light grey calx, which is pretty refractory in the fire, but melts at laſt to a glaſs of a reddiſh brown colour.

d. It diſſolves in ſpirit of ſea-ſalt and aqua regia, but is only corroded by the ſpirit of nitre into a white calx; it is precipitated out of the aqua regia by water.

e. It has an emetic quality when its calx, glaſs, or metal, is diſſolved in an acid, except when in the ſpirit of nitre, which has not this effect.

f. It amalgamates with quickſilver, if the regulus, when fuſed, is put to it; but the quickſilver ought for this purpoſe to be covered with warm water: It amalgamates

with

with it likewiſe, if the regulus of antimony be previouſly melted with an addition of lime.

SECT. CCXXXIII.

Antimony is found in the earth.

A. Native, *Antimonium nativum, ſive, Regulus Antimonii nativus.*

This is of a ſilver colour, and its texture is compoſed of pretty large ſhining planes.

This kind was found in Carls Ort, in the mine of Salberg, about the end of the laſt century; and ſpecimens thereof have been preſerved in collections under the name of an arſenical pyrites, until the mine-maſter Mr. Von Swab diſcovered its real nature, in a treatiſe he communicated to the Royal Academy of Sciences at Stockholm, in the year 1748. Among other remarkable obſervations in this treatiſe, it is ſaid, firſt, That this native antimony eaſily amalgamated with quickſilver; doubtleſs, becauſe it was imbedded in a limeſtone; ſince, according to Mr. Pott's experiments, an artificial regulus of antimony may, by means of lime, be diſpoſed to an amalgamation: Secondly, That when brought in form of a calx, it ſhot into criſtals during the cooling *.

* Since native antimony, or, as it is commonly called, regulus of antimony, was never before deſcribed, the poſſibility of its exiſtence has been denied; and when this here mentioned was diſcovered, ſomebody publiſhed ſome doubts of the truth of the whole affair, upon no better foundation than that the ſpecimens were very ſmall for making experiments, and that it was uncertain if ev r mineraliſed antimony had been found in the mine of Salberg: but thoſe reaſons are not ſufficient to refute experiments, becauſe men of experience are

SECT. CCXXXIV.

B. Mineralifed Antimony, *Antimonium mineralifatum.*

1. With fulphur, *Antimonium fulphure mineralifatum. Antimonium propriè fic dictum.*

This is commonly of a radiated texture, compofed of long wedge-like flakes or plates; it is nearly of a lead colour, and rough to the touch.

a. Of coarfe fibres.

b. Of fmall fibres.

c. Steel-grained, from Saxony and Hungary.

d. Criftallifed, from Hungary.

1. Of a prifmatical, or of a pointed pyramidal figure, in which laft circumftance the points are concentrical.

I have feen a fpecimen of this, in which the criftals were covered with very minute criftals of quartz, except at the extremities, where there was always a little hole: This fpecimen was given for a *flos ferri* fpar.

are always able to make true experiments on fmall pieces of native metals, nor is there any neceffity that mineralifed metals fhould always be found along with the native ores of the fame fpecies; but this really happens with this antimony in the mine of Salberg. We ought to be contented with conclufions drawn from experiments, until the fallacioufnefs of fuch experiments is demonftrated: And it were to be wifhed, that all pretended difcoveries were fupported by experiments, and an enumeration of the phenomena which happen in them; we fhould then not contradict things, which perhaps may be true, though, for want of this precaution, they feem fcarce credible; as, for inftance, the native tin, lead, and iron, the zink fpar, and an unknown femi-metal in the mica.

SECT.

SECT. CCXXXV.

2. With ſulphur and arſenic, *Antimonium auripigmento mineraliſatum.* Red antimony ore, *Antimonium ſolare.*

This is of a red colour, and has the ſame texture with the preceding, though its fibres are not ſo coarſe.

a. With ſmall fibres.

b. With abrupt broken fibres, from Braunſdorff in Saxony, and from Hungary.

All antimonial ores are ſomewhat arſenical, but this is more ſo than the preceding kinds.

SECT. CCXXXVI.

C. With ſulphurated ſilver. Plumoſe ſilver ore. Sect. clxxiii.

D. With ſulphurated ſilver, copper and arſenic. Sect. clxxiv.

E. With ſulphurated lead. Sect. cxc.

SECT. CCXXXVII.

OBSERVATIONS on ANTIMONY.

By the name of Antimony is commonly underſtood the crude antimony, (which is compounded of the metallic part and ſulphur) as it is melted out of the ore (Sect. ccxxxiv.); and by the name of Regulus, the pure ſemi-metal; although this laſt begins now to be better diſtinguiſhed from the other metals.

The alchemiſts have very much employed antimony in their experiments; ſome of them chiefly on on account that it is found in the Hungarian gold mines: Yet ſtill we know no more of the conſtituent parts of this ſemi-metal than the others, notwithſtanding all that has been wrote on the ſubject. Some ſay that its earth is not vitrifiable, becauſe it is volatile, which is perfectly contrary to experience: And if volatility is the characteriſtic of a mercurial earth, the pipe clay from Cologne ought to be of the ſame nature. Perhaps it is better to ſay that the calx of antimony is volatile, and is incapable of being reduced into a metallic ſtate with phlogiſton alone, but may be melted into glaſs; and ſuch is its nature, though we do not know the reaſon of it.

SECT. CCXXXVIII.

5. Arſenic, *Arſenicum*. This is
   - *a*. In its metallic form nearly of the ſame colour as lead, but brittle, and changes ſooner its ſhining colour in the air, firſt to yellow, and afterwards to black.
   - *b*. It appears laminated in its fractures, or where broken.
   - *c*. Is very volatile in the fire, burns with a ſmall flame, and gives a very diſagreeable ſmell, like garlick.
   - *d*. It is, by reaſon of its volatility, very difficult to be reduced, unleſs it is mixed with other metals: However, a regulus may be got from the white arſenic, if it is quickly melted with equal parts of potaſhes and ſoap; but this regulus contains generally ſome cobalt, moſt of the white arſenic being produced from the cobalt ores during their calcination. The white arſenic, mixed with a phlogiſton, ſublimes like-

likewise into octoëdral cristals of a metallic appearance, whose specific gravity is 8,308.

e. The calx of arsenic, which always, on account of its volatility, must be got as a sublimation, is white, and easily melts to a glass, whose specific gravity is 5,000. When sulphur is blended in this calx, it becomes of a yellow, orange, or red colour; and according to the degrees of colour is called Orpiment or yellow arsenic, Sandarach, Realgar or red arsenic, and also *Rubinus Arsenici.*

f. This calx and glass are dissoluble in water, and in all liquids; though not in all with the same facility. In this circumstance arsenic resembles the salts, for which reason it also might be ranked in that class. Sect. cxix.

g. The regulus of arsenic dissolves in spirit of nitre; but as it is very difficult to have it perfectly free from other metals, it is yet very little examined in various menstrua.

h. It is poisonous, especially in form of a pure calx or glass: But probably it is less dangerous when mixed with sulphur, since it is proved by experience, that the men at mineral works are not so much affected by the smoak of this mixture, as by the smoak of lead; and that some certain nations make use of the red arsenic in small doses as a medicine.

i. It unites with all metals, and is likewise much used by nature itself to dissolve, or, as we term it, to mineralise the metals, to which its volatility, and dissolubility in water, must greatly contribute. It is likewise most generally mixed with sulphur.

k. It abſorbs or expels the phlogiſton, which has coloured glaſſes, if mixed with them in the fire.

SECT. CCXXXIX.

Arſenic is found,

1. Native, *Arſenicum nativum*; called *Scherbencobolt* and *Fliegenſtein* by the Germans.

It is of a lead colour when freſh broken, and may be cut with a knife, like black lead, but ſoon blackens in the air. It burns with a ſmall flame, and goes off in ſmoak.

A. Solid and teſtaceous, *Arſenicum nativum particulis impalpabilibus teſtaceum. Scherbencobolt.*

This is found in the mines of Saxony, the Hartz, and Hungary.

B. Scaly, *Particulis micaceis*, from Winorn at Kongſberg in Norway.

C. Friable and porous, *Friabile et poroſum. Fliegenſtein.*

1. With ſhining fiſſures, *Fiſſuris nitentibus*, from Annaberg in Saxony.

This is by ſome called *Spigel Cobolt*, (*Mincra cobalti ſpecularis*) according to their notions of the affinity of theſe metals to one another. However, there always remains after the volatiliſation of the Scherbencobolt, ſome calx, either of cobalt or biſmuth, and ſome ſilver, though in too ſmall a quantity to deſerve any notice.

SECT. CCXL.

2. In form of a calx, *Arſenicum calciforme.*

A. Pure, or free from heterogeneous ſubſtances, *Calx arſenici nativa pura.*

1. Looſe

1. Loose or powdry. This sort is found at Giesshubel in Saxony, but is collected in a much purer state on the sides of the rock in some mines.

2. Indurated or hardened. This is found in form of white semi-transparent cristals, in small cavities within the Scherbencobolt, at Andreasberg in the Hartz, and in Saxony, but is very scarce.

SECT. CCXLI.

B. Mixed with sulphur, *Calx arsenici sulphure mixta.*

1. Hardened.
   - *a.* Yellow. Orpiment, *Auripigmentum*, from Hungary.
   - *b.* Red. Native Realgar or Sandarach, from Hungary, Andreasberg in the Hartz, Saxony, and Rotendal in Elfdalen in Sweden *.

SECT. CCXLII.

C. Mixed with the calx of tin, in the tin-grains. Sect. clxxxi.

D. With sulphur and silver, in the Rothgulden, or red silver ore. Sect. clxx.

E. With calx of lead, in the lead-spar. Sect. clxxxvi.

F. With calx of cobalt, in the efflorescence of cobalt. Sect. ccxlviii.

* The orpiment may perhaps be found naturally in loose scaly powder, as it is sometimes met with in the shops: However, I have only seen the hardened sort in collections.

SECT. CCXLIII.

3. Mineralised arsenic, *Arsenicum mineralisatum.*

A. With sulphur and iron, *Arsenicum ferro sulphurato mineralisatum.* Arsenical pyrites or marcasite *.

This alone produces red arsenic, when calcined, and is found in great quantities in the mines of Losas in the province of Dalarne: It is of a deeper colour than the following.

B. With iron only, *Arsenicum metalliforme ferro mixtum. Misspickel.* This differs with regard to its particles, being

1. Steel-grained;
2. Coarse-grained, from Westersilfverberget;
3. Cristallised.
   a. In an octoëdral figure. This is the most common kind.
   b. Prismatical, from the mines of Salberg, Westersilfverberget, and Hellefors in Westmanland, and in many places of foreign countries †.

SECT. CCXLIV.

C. With cobalt, almost in all cobalt ores. Sect. ccxlviii.

D. With silver. Sect. clxxi. clxxii.

E. With copper. Sect. cxcix.

F. With antimony. Sect. ccxxxv.

* These kinds in Cornwall are called Silvery or White Mundics, and Plate Mundics. D. C.

† The sulphureous marcasite is added to this kind, when red arsenic is to be made; but in Sweden it is scarcer than the sulphureous arsenical pyrites.

SECT.

SECT. CCXLV.

OBSERVATIONS on ARSENIC.

Such ores as conſiſt of arſenic united ſolely with iron, or with iron and ſulphur, cannot be employed to any other uſe than to the preparation of arſenical products; for which reaſon they ought to be ranged among the arſenic ores. Some have indeed denied this difference between the arſenical pyritæ; but it is however neceſſary to make ſome difference, with reſpect to the preſence or abſence of ſulphur, although the greateſt quantity of arſenic is got from the calcination of the cobalt ores, and that the true arſenical pyritæ do not deſerve to be ſeparately employed.

Although it is difficult to reduce the arſenic by way of precipitation, one cannot for that reaſon deny it to be of a metallic nature; for the ſame way of reaſoning might have been uſed againſt the zink in the calamine, before the method to extract that ſemi-metal in its metallic ſtate, now known, was diſcovered: But thoſe who know that metals only can be mixed with metals, ſo as to preſerve the ſolidity and ſome ductility in the compound, and who at the ſame time are ignorant of any metallic earth, which cannot be reduced to its metallic ſtate again, could never entertain ſuch notions.

It is indeed true, that ſulphur, in regard to the brittleneſs which it produces in metals, is of no worſe effect than arſenic; but this laſt may by itſelf, and mixed only with a pure phlogiſton, be ſublimed into a metallic form, which is more plainly ſeen in the Scherbencobolt (Sect. ccxxxix.). I eaſily perceive that it may be objected by thoſe, who deny arſenic to be a ſemi-metal, that it may as well be a ſalt of a peculiar nature; as, for inſtance, the vitriolic acid; and that it may, like ſulphur, diſſolve the metals in form of a kind of regulus; and farther, that its aſſuming a metallic appearance, when it is united with an inflammable ſubſtance, is of no conſequence, ſince there are fiſh and inſects who have a ſhining metallic colour: But all this does not deſerve an anſwer, ſince it has been already agreed, that ſyſtems muſt not be too ſeverely criticiſed.

SECT. CCXLVI.

6. Cobalt, *Cobaltum.*

This ſemi-metal is,

a. Of a whitiſh grey colour, nearly as fine tempered ſteel.

b. Is hard and brittle, and of a fine grained texture; hence it is of a duſky, or not ſhining appearance.

c. Its ſpecific gravity to water is 6000 : : 1000.

d. It is fixt in the fire, and becomes black by calcination; it then gives to glaſſes a blue colour, inclining a little to violet, which colour, of all others, is the moſt fixed in fire.

e. The concentrated oil of vitriol, aqua fortis, and aqua regia, diſſolve it; and the ſolutions become red. The cobalt calx is likewiſe diſſolved by the ſame menſtrua, and alſo by the volatile alcali, and the ſpirit of ſea-ſalt.

f. When united with the calx of arſenic in a ſlow (not a briſk) calcining heat, it aſſumes a red colour: The ſame colour is naturally produced by way of eſfloreſcence, and is then

then called the *bloom* or *flowers of cobalt*. When cobalt and arſenic are melted together in an open fire, they produce a blue flame.

g. It does not amalgamate with quickſilver by any means hitherto known.

h. Nor does it mix with biſmuth, when melted with it, without addition of ſome medium to promote their union.

SECT. CCXLVII.

The cobalt is moſt commonly found in the earth mixed with iron.

A. In form of a calx, *Cobaltum calciforme.*

1. With iron without arſenic, *Martiale abſque arſenico.*

a. Looſe or friable, *Minera cobalti calciformis pulverulenta*. Cobalt ochre, *Ochra cobalti nigra*. It is black, and like the artificial zaffre.

b. Indurated, *Minera cobalti calciformis indurata*. *Minera cobalti vitrea*, the *ſchlacken* or ſlag cobalt.

This is likewiſe of a black colour, but of a glaſſy texture, and ſeems to have loſt that ſubſtance which mineraliſed it, by being decayed or weathered. It is often confounded with the Scherbencobolt, for it is ſeldom quite free from arſenic; and there may perhaps exiſt a progreſſive ſeries from the Schlacken kind to the Scherbencobolt kind.

SECT. CCXLVIII.

2. With the calx of arſenic, *Minera cobalti calciformis calce arſenici mixta*. Cobalt-blut, *Ochra cobalti rubra*, Bloom, Flowers, or Efflorefcence of cobalt.
   - *a.* Looſe or friable, *Ochra cobalti pulverulenta*. This is often found of a red colour like other earths, ſpread very thin on the cobalt ores, and is, when of a pale colour, erroneouſly called Flowers of Biſmuth.
   - *b.* Indurated, *Ochra cobalti rubra indurata*. Hardened Flowers of Cobalt.

     This is commonly criſtalliſed in form of deep red ſemi-tranſparent rays or radiations: It is found at Schneeberg in Saxony *.

SECT. CCXLIX.

B. Mineraliſed, *Cobaltum mineraliſatum*.

1. With arſenic and iron in a metallic form, *Cobaltum ferro & arſenico metalliformis mineraliſatum*; *vulgò* Cobaltum *dictum*.

   This is of a dim colour when broken, and not unlike ſteel. It is found
   - *a.* Steel-grained, from Loos in the pariſh of Farila, in the province of Helſingeland, and at Schneeberg in Saxony.
   - *b.* Fine-grained, from Loos.

* A white cobalt-earth, or ochre, is ſaid to have been found. It has been ſeen and examined by a celebrated mineraliſt, who has found it in every reſpect, except the colour, to reſemble the cobalt flowers; and it is very poſſible, that thoſe cobalt flowers might in length of time have loſt their red colour, and become white.

c. Coarſe-

c. Coarſe-grained.

d. Criſtalliſed.

1. In a dendritical or arboreſcent form, from Schneeberg.
2. Polyëdral, with ſhining ſurfaces; the *Glanzkobolt* of the Germans, from Schneeberg.
3. In radiated nodules, from Kongſberg in Norway.

SECT. CCL.

2. With ſulphurated iron, *Cobaltum ferro ſulphurato mineraliſatum.*

This is of a lighter colour than the preceding, nearly like to tin or ſilver. It is found

a. Criſtalliſed.

1. In a polygonal form.

a. Of a flaggy texture.

b. Coarſe-grained.

This kind is found in Baſtnasgrufva át Riddarſhyttan in Weſtmanland, and diſcovers not the leaſt mark of arſenic. The coarſe-grained becomes ſlimy in the fire, and ſticks to the ſtirring hook during the calcination, in the ſame manner as many regules do; and is a kind of regule prepared by nature.

That ſort of a flaggy texture is very martial, and is deſcribed by the mine-maſter Mr. Brandt, in the Acts of the Swediſh Academy of Sciences for the year 1746. Both theſe give a beautiful colour.

SECT.

SECT. CCLI.

3. With ſulphur, arſenic, and iron, *Cobaltum cum ferro ſulphurato et arſenicato mineraliſatum.*

This reſembles the arſenicated cobalt ore, being only rather of a whiter or lighter colour. It is found

a. Coarſe-grained.

b. Criſtalliſed.

1. In a polygonal figure, with ſhining ſurfaces, or *Glanzkobolt.*

It occurs at Tunaberg in the province of Sodermanland, partly of a white or light colour, and partly of a ſomewhat reddiſh yellow.

SECT. CCLII.

4. With ſulphurated and arſenicated nickel and iron; ſee *Kupfernickel,* Sect. cclvi.

SECT. CCLIII.

OBSERVATIONS on COBALT.

Since the glaſs of cobalt, which has been entirely freed from all arſenic in the calcination, and from the iron and the other metals by ſcorification, as when it is prepared from criſtalliſed cobalt flowers, may by addition of phlogiſton be melted to a true cobalt regulus, which differs in its qualities from all other metals; there can be no reaſon for denying the cobalt a place among the ſemi-metals, as many authors even at this time do, notwithſtanding

withſtanding the ſeveral reaſons given, which might induce them to examine nearer into the ſubject.

It was the mine-maſter Mr. Brandt who firſt diſcovered this ſemi-metal, and deſcribed it in the abovementioned Hiſtory of Semi-metals, in the *Acta Upſalienſia* for the year 1735.

The brittleneſs of the cobalt regulus is no proof againſt its being a ſemi-metal, that property being the baſis on which the diſtinction between the ſemi-metals and metals is founded. The earth of cobalt is fixed and vitrifiable in the fire, as well as that of copper and iron; and the colour of its glaſs being ſo immutable in the fire, proves it to be a particular ſubſtance, diſtinct from other earths and metallic calces. The experiment of making a cobalt glaſs from iron or ſteel and arſenic, will certainly never ſucceed, unleſs the arſenic, employed for that purpoſe, has been made from a cobalt ore; but if the origin of the colour ſhould be aſcribed to an irreducible metallic earth, there is no occaſion for this experiment, becauſe a cobalt regulus may be prepared ſo as to be free both from arſenic and iron, the preſence of this laſt metal being eaſily diſcovered by the loadſtone. It is therefore now unneceſſary and ridiculous to continue the old definitions of the cobalt, in which the Speiſe, which partly is a cobalt regulus, and partly a compound, conſiſting of nickel, cobalt, and biſmuth, united with ſulphur and arſenic, is either confounded with the ſemi-metal itſelf, or quoted as a proof, that a cobalt regulus cannot exiſt in any other manner than as a dead earth involved in heterogeneous ſubſtances; which is the ſame as to conclude, that no pure copper can be produced from the copper regules or fuſions, called *Trottſten* or *Spurſten.*

These

These falſe notions have, however, induced a new author to deſcribe the cobalt as a mixture of iron, copper, lead, biſmuth, and arſenic; but he has not at the ſame time publiſhed any experiments which might ſerve to confirm his opinion; amongſt which, with great reaſon, ſuch experiments are expected as imitate nature in this compoſition, which is pretended to conſiſt of ſo many different things. It might then have been calculated, if it would be profitable to eſtabliſh manufactures for making cobalt-glaſs, or zaffre, in any part of the world, where the above-mentioned ingredients can be had.

The word Cobalt in Germany, and eſpecially at the mineral works in Saxony, is applied to the damps, the arſenic, its vapours, and their effects on man; which has induced the vulgar alſo to apply it to ſome pretended evil ſpirit, which is ſaid to dwell in the mines: But time will aboliſh theſe ſuperſtitions, which have their origin from ignorance.

SECT. CCLIV.

7. Nickel, *Niccolum.*

This is the lateſt diſcovered ſemi-metal. It was firſt deſcribed by its diſcoverer Mr. Cronſtedt in the Acts of the Royal Academy of Sciences at Stockholm, for the years 1751 and 1754, where it is ſaid to have the following qualities: That

1. It is of a white colour, which however inclines ſomewhat to red.
2. Of a ſolid texture, and ſhining in its fractures.
3. Its ſpecific gravity to water is as 8,500 : : 1000.

4. It is pretty fixt in the fire; but together with the ſulphur and arſenic, with which its ore abounds, it is ſo far volatile, as to riſe in form of hairs and branches, if in the calcination it is left without being ſtirred.
5. It calcines to a green calx.
6. This calx is not very fuſible, but however tinges glaſs of a tranſparent reddiſh brown, or jacinth colour.
7. It diſſolves in aqua fortis, aqua regia, and the ſpirit of ſea-ſalt, but more difficultly in the vitriolic acid, tinging all theſe ſolutions of a deep green colour. Its vitriol is of the ſame colour; but the colcothar of this vitriol, as well as the precipitates from the ſolutions, become by calcination of a light green colour.
8. Theſe precipitates are diſſolved by the ſpirit of ſal ammoniac, and the ſolution has a blue colour; but being evaporated, and the ſediment reduced, there is no copper, but a nickel regulus is produced.
9. It has a ſtrong attraction to ſulphur; ſo that when its calx is mixed with it, and puts on a ſcorifying teſt under the muffel, it forms with the ſulphur a regule: This regule reſembles the yellow ſteel-grained copper-ores, and is hard and ſhining on its convex ſurface.
10. It unites with all the metals, except quickſilver and ſilver. When the nickel regulus is melted with the latter, it only adheres cloſe to it, both the metals lying near one another on the ſame plane; but they are eaſily ſeparated with a hammer. Cobalt has the ſtrongeſt attraction to nickel, after

after that to iron, and then to arsenic. The two former cannot be separated from one another but by their scorification, which is easily done, since

11. This semi-metal retains its phlogiston a long time in the fire, and its calx is reduced by the help of a very small portion of inflammable matter: It requires, however, a red heat before it can be brought into fusion, and melts a little sooner, or almost as soon as copper or gold, consequently sooner than iron.

SECT. CCLV.

The nickel is found.

A. In form of a calx, *Niccolum calciforme.* Nickel ochre, *Ochra niccoli.*

1. Mixed with the calx of iron, *Ochra niccoli martialis.*

This is green, and is found in form of flowers on Kupfernickel. In Normarken in the province of Wermeland, this ochre was found without any visible nickel mixed in the clay, which contained a great quantity of native silver. Sect. clxviii.

SECT. CCLVI.

B. Mineralised nickel, *Niccolum mineralisatum.*

1. With sulphurated and arsenicated iron and cobalt, *Niccolum ferro & cobalto arsenicatis et sulphuratis mineralisatum. Cuprum nicolai seu niccoli. Kupfernickel.*

This is of a reddish yellow colour, and is found

a. Of a flaggy texture, in Saxony.

b. Fine-grained, and

c. Scaly, in Loos cobalt mines in the province of Helsingeland; at which place it is of a lighter colour than the foreign ones. These two are often from their colour confounded with the liver-coloured marcasite. Sect. cliii.

SECT. CCLVII.

2. With the acid of vitriol, *Niccolum acido vitrioli mineralisatum.*

This is of a beautiful green colour, and may be extracted out of the nickel ochre, (Sect. cclv.) or efflorescence of the Kupfernickel.

SECT. CCLVIII.

Observations on Nickel.

The cobalt, bismuth, and nickel, are commonly found together in the same mines, by which it happens, that, when the first, as the most useful of them all, is to be made into glass, the adherent nickel, according to its nature, unites with the sulphur and arsenic, of which some portion remains after the calcination, and makes with them a regule. When these minerals (the sulphur and arsenic) are in greater quantity than is wanted for the nickel, they likewise reduce some part of the calces of the cobalt and bismuth; and in this case the nickel, as a medium, uniting the other two, otherwise not miscible semi-metals, incorporates them into the same regule. From hence arises a difference in the contents of different regules; and from this difference people, who have

have not ſufficient experience, form to themſelves falſe notions of the whole compound, and of each part contained in it: For which reaſon they chuſe rather to retain that definition of the Kupfernickel which has received its ſanction from the earlieſt authors, than to admit the concluſion to which Mr. Cronſtedt's experiments ſeem to lead.

For my own part, I have found myſelf obliged to follow the opinion of the latter, partly becauſe I am tired with thoſe common epithets given to unknown bodies; ſuch as, *wild*, *refractory*, *rapacious*, *arſenical*, *irreducible*, *metallic earth*, &c. &c. which regard the effect alone and not its cauſe; and partly becauſe I have not, beſides the nickel, found any metal or metallic compoſition, which

1. Becomes green when calcined.

2. Yields a vitriol, whoſe colcothar alſo becomes green in the fire.

3. So eaſily unites with ſulphur, and forms with it a regule of ſuch a peculiar nature, as the nickel does in this circumſtance; and that

4. Does not unite with ſilver, but only adheres or ſticks cloſe to it, when they have been melted together.

The nickel not having yet been found free from cobalt and iron, is the reaſon why it was not diſcovered. This was the caſe alſo with the cobalt. Platina del pinto perhaps, in the ſame manner, might for a long time have been mixed in the gold, at certain places, where it is ſaid to be naturally paler than any where elſe in the world. But the exiſtence of ſuch things cannot any longer be denied, ſince the method is diſcovered to get them ſeparate, and free from heterogeneous ſubſtances. It indeed would be the ſame thing, as if in a country where ſilver is never found but in the potter's lead ore, any perſon ſhould deny the exiſtence of either of theſe metals, or inſiſt upon it, that one is produced from the other.

It is remarkable, that the precipitates of nickel give a blue colour to the ſpirit of ſal ammoniac, when they are diſſolved in it; without ſhewing beſides any marks of copper, which, however, could not be concealed if there were any; for if a ſmall quantity of copper is melted with the nickel, and kept in a ſtrong fire with it, the copper ſoon ſeparates, and ſcorifies, tinging the glaſs firſt of a reddiſh brown opaque colour, and, the fire being further forced, it then makes it tranſparent and green, as uſual.

There is no danger attending the encreaſing the number of the metals. Aſtrological influences are now in no repute among the learned, and we have already more metals than planets within our ſolar ſyſtem. It would perhaps be more uſeful to diſcover more of theſe metals, than idly to loſe our time in repeating the numberleſs experiments which have been made, in order to diſcover the conſtituent parts of the metals already known. In this perſuaſion, I have avoided to mention any hypotheſes about the principles of the metals, the proceſſes of mercurification, and other things of the like nature, with which, to tell the truth, I have never troubled myſelf.

APPENDIX.

SECT. CCLIX.

I Have already in the Preface mentioned the reasons why the Saxa and Fossils commonly called Petrefactions, cannot be ranked in a mineral system: And I am almost persuaded, that the same reason which has prevailed on me, will likewise after mature consideration be approved by others. Mean while, since these bodies, especially the latter, occupy so considerable a place in most mineral collections, and the former must necessarily be taken notice of by the miners in the observations they make in the subterranean geography, I would not entirely omit them here, but have tried to put them in such an order as may answer that purpose, for which miners and mineralists pay any regard to them.

SECT. CCLX.

The FIRST ORDER.

SAXA. PETRÆ.

I divide these into two kinds.

1. Compound Saxa, *Saxa composita*,

Are such stones whose particles, consisting of different substances, are so exactly fitted and joined together, that no empty space, or even cement, can be perceived between them; which seems to indicate, that some, if not all, of of theſe ſubſtances have been ſoft at the inſtant of their union.

2. Conglutinated ſtones, *Saxa conglutinata*,

Are ſuch ſtones whoſe particles have been united by ſome cementitious ſubſtance, which, however, is ſeldom perceivable, and which often has not been ſufficient to fill every ſpace between the particles: In this caſe the particles ſeem to have been hard, worn off, and in looſe, ſingle, unfigured pieces, before they were united.

SECT. CCLXI.

1. Compound Saxa, *Saxa compoſita.*

A. Ophites. Scaly limeſtone with kernels or bits of ſerpentine ſtone in it, *Saxum compoſitum particulis calcareis et argillaceis.*

1. *Kolmord's marble.* It is white and green.
2. *Serpentino antico*, is white, with round pieces of black ſteatites in it. This muſt not be confounded with the *Serpentino verde antico.* Sect. cclxvi.
3. The *Haraldſio marble.* White, with quadrangular pieces of a black ſteatites.
4. The *Marmor Pozzevera di Genoua.* Dark green marble, with white veins.

This kind receives its fine poliſh and appearance from the ſerpentine ſtone.

SECT. CCLXII.

B. Stellſten or *Geſtellſtein, Saxum compoſitum particulis quartzoſis & micaceis.*

1. Of diſtinct particles, *Particulis diſtinctis.*

This is found at Garpenberg in the province of Dalarne. It is likewiſe met with in the other mineral mountains of Sweden. In ſome of theſe the quartzoſe particles predominate, and in others, the micaceous: In the laſt caſe it is commonly ſlaty, and eaſy to ſplit.

2. Of particles which are wrapt up in one another, *Particulis quartzoſis micâ convolutis.*
   a. Whitiſh grey, from Morthernberget in Norberke in Dalarne.
   b. Greeniſh, at Salberg in Weſtmanland.
   c. Reddiſh, from the pariſh of Malung in Dalarne.

   Both theſe kinds of Stellſten are for their reſiſtance to the fire employed in building furnaces; but the latter is the beſt, becauſe it ſeems at the ſame time to contain a little of a refractory clayiſh ſubſtance: It however cracks very ſoon, if the flat ſide of the ſtratum, inſtead of the extremity, is turned towards the fire. It is alſo of great uſe in mills, if the other or fellow-ſtone is made of the mill-ſtone from Arſunde, which is a Saxum of the conglutinated kind, or a coarſe ſand-ſtone. It is lucky for œconomical purpoſes, that the plates of theſe ſtones are ſo thick, although thereby they are not ſo eaſily ſplit.

SECT. CCLXIII.

C. Norrka. Murkſten of the Swedes. *Saxum compoſitum micâ, quartzo et granato.*

1. With diſtinct garnets or ſhirl, *Granatis diſtinctis cryſtalliſatis.* *a.* Light

a. Light grey, from Selbo in Norway.
b. Dark grey, with very ſmall garnets, from Quarnberget in the pariſh of Soderli in the province of Jemteland.
c. Dark grey, with priſmatical, radiated, or fibrous cockle or ſhirl, from the village of Handol, in the pariſh of Are in Jemteland.

2. With kernels of garnet ſtone, *Particulis granatinis indeterminatis.*

a. Of pale red garnet ſtone, from Stollberget in Norberke in Dalarne.

The firſt of this kind, whoſe ſlaty ſtrata makes it commonly eaſy to be ſplit, is employed for mill-ſtones, which without difficulty diſtinguiſh themſelves for that purpoſe, if ſand is firſt ground with them, becauſe the ſand wears away the micaceous particles on the ſurfaces, and leaves the garnets prominent, which renders the ſtone fitter for grinding the corn.

SECT. CCLXIV.

D. The Whetſtone, *Cos. Saxum compoſitum micâ, quartzo, et forſan argillâ martiali in nonnullis ſpeciebus.*

1. Of coarſe particles, *Particulis diſtinctis.*

a. White, from Wanga in the province of Skone.
b. Light grey, from Tellemarken in Norway.

2. Of fine particles, *Particulis minoribus.*

a. Liver brown colour, from Selbo in Norway.

b. Blackiſh grey, from Lerwik at Hellefors in Weſtmanland, and from Cologne in Germany.

c. Light grey, from Hellefors in Weſtmanland.

d. Black. The table ſlate, or that kind uſed for large tables and for ſchool-ſlates.

The naked eye, and the magnifying glaſs much better, diſcovers the micaceous particles in this kind to be as it were twiſted in one another; ſome clay ſeems likewiſe to enter into the compoſition: However, it cannot yet be certainly aſſerted that it is real mica which has that appearance in this kind.

3. Of very minute and cloſely combined particles, *Cos particulis conſtans impalpabilibus durus*. The Turky ſtone.

This is of an olive colour, and ſeems to be the fineſt mixture of the firſt ſpecies of this genus. It is found in looſe ſtones at Biorkſkoginas in the pariſh of Hellefors in Weſtmanland, though not perfectly free from croſs veins of quartz, which always are in the ſurface of the rock, and ſpoil the whetſtones. It is alſo ſaid to be found in Tellemarken in Norway. The beſt of this ſort come from the Levant, and are pretty dear. The whetſtone kinds, when they ſplit eaſily, and in thin plates, are very fit to cover houſes with, though moſt of them are not uſed for that purpoſe.

SECT.

SECT. CCLXV.

E. The *Telgsten* of the Swedes. *Lapis ollaris. Saxum compositum steatite et micâ.*

a. Light grey, from Fahlun, and also Byxberget at Norberke.

b. Whitish yellow, from Siksioberget in Norberke.

c. Dark grey, from Riddarshyttan.

d. Dark green, from Salvisto in the parish of Tamela in Finland.

This is employed with great advantage to build fire-places and furnaces, &c. and when it is slaty, the extremities of the strata must be turned towards the fire.

SECT. CCLXVI.

F. Porphyry, *Porphyrites.* Italorum *Porfido. Saxum compositum jaspide et feltspato, interdum micâ et basalte.*

a. Its colour is green, with light green feltspat, *Serpentino verde antico.* It is said to have been brought from Egypt to Rome, from which latter place the specimens of it now come.

b. Deep red, with white feltspat, from Italy, and Egern in Norway.

c. Black, with white and red feltspat, from Klitten, in the parish of Elfdalen in Dalarne.

d. Reddish brown, with light-red and white feltspat, from Hykieberget in Elfdalen, and Gustavstrom, in the parish of Gosborn in the province of Wermeland.

e. Dark grey, with white grains of feltſpat alſo, from Guſtavsſtrom.

Many varieties of this kind, in regard to colour, are found in form of nodules or looſe ſtones in Sweden; but I have only mentioned the hardeſt and fineſt of thoſe which are found in the rocks; becauſe, beſides theſe, there are coarſe porphyries found, which ſcarce admit of any poliſh. The dark red porphyry has been moſt employed for ornaments in building: yet it is not the only one known by the name of *Porfido*, the Italians applying the ſame name alſo to the black kind.

SECT. CCLXVII.

G. The *Trapp* of the Swedes. *Saxum compoſitum jaſpide martiali molli, ſeu argillâ martiali induratâ, et - - - -*

This kind of ſtone ſometimes conſtitutes or forms whole mountains; as, for example, the mountain called Hunneberg, in the province of Weſtergottland, and at Drammen in Norway; but it is oftener found in form of veins in mountains of another kind, running commonly in a ſerpentine manner, contrary or acroſs to the direction of the rock itſelf. It is not homogeneous, as may be plainly ſeen at thoſe places where it is not preſſed cloſe together; but where it is preſſed cloſe, it ſeems to be perfectly free from heterogeneous ſubſtances. When this kind is very coarſe, it is interſperſed with feltſpat; but it is not known if the finer ſorts likewiſe contain any

any of it. Besides this, there are also some fibrous particles in it, and something that resembles a calcareous spar: This however does not ferment with acids, but melts as easy as the stone itself, which becomes a black solid glass in the fire. By calcination it becomes red, and yields in assays 12 or more per cent. of iron. No other sort of ore is to be found in it, unless now and then somewhat merely superficial lies in its fissures; for this stone is commonly, even to a great depth in the rock, cracked in acute angles, or in form of large rhomboidal dice. It is employed at the glass-houses, and added to the composition of which bottles are made. By the Germans it is called *Schwach* or *Schwartsstein*; at the Swedish glass-works, *Trappskiol*, *Tegelskiol*, or *Swartskiol*; and at Jarlsberg in Norway, *Blabest*. In the air it decays a little, leaving a powder of a brown colour; it cracks commonly in the fire, and becomes reddish brown if made red hot. It is found

1. Of coarse chaffy particles, *Particulis majoribus acerosis*:
   - *a*. Dark grey, from the top of Kinnekulle in the province of Westergottland.
   - *b*. Black, from Stallberget at Ostersilfverberget in the province of Dalarne.
2. Coarse-grained, *Particulis majoribus granulatis*.
   - *a*. Dark grey, from the uppermost stratum at Hunneberg in Westergottland.
   - *b*. Reddish, from Bragnas in Norway.
   - *c*. Deep brown, from Gello in Norway.

3. Of

3. Of fine imperceptible particles, *Particulis impalpabilibus.*

a. Black. The Touchſtone, *Lapis Lydius*, from Salberg mine, Hellefors, Weſterſilfverberget, and Norberg in Weſtmanland, and Oſterſilfverberget in Dalarne, &c.

b. Blueiſh, from Oſterſilfverberget.

c. Grey, from Dalwik in the pariſh of Sorberke in Dalarne.

d. Reddiſh, from Dalſtugun in the pariſh of Rettwik in Dalarne *.

SECT. CCLXVIII.

H. Amygdaloides. Saxum baſi jaſpideâ martiali, cum fragmentis ſpati calcarei et ſerpentini, figurâ ellipticâ †.

It is a martial jaſper, in which elliptical kernels of calcareous ſpar and ſerpentine-ſtone are included.

a. Red, with kernels of white limeſtone, and of a green ſteatites, from Gello and Gullo in Norway, and the Hartz in Germany.

This is of a particular appearance, and when calcined is attracted by the loadſtone; it decays pretty much in the air, and has ſome affinity with the Trapp, (Sect. cclxvii.) and alſo with the Porphyry (Sect. cclxvi.). There are ſome-

* The black variety (3. *a.*) is ſometimes found ſo compact and hard, as to take a poliſh like the black agat; it melts, however, in the fire to a black glaſs, and is, when calcined, attracted by the loadſtone. Such a kind is found in the pariſh of Arla in the province of Sodermanland.

† The Carpolithi or Fruit-ſtone rocks of the Germans. D. C.

times

times found pieces of native copper in this ſtone at Gullo.

SECT. CCLXIX.

I. The *Gronſten* of the Swedes. *Saxum compoſitum micâ et hornblende.* Sect. lxxxviii.

Its baſis is hornblende, interſperſed with mica. It is of a dark green colour, and is dug in ſeveral places in Smoland, where it is employed in the iron furnaces as a flux to the bog ore (Sect. ccii.). It is alſo found in other places, as at Rettwik in Dalarne, and in the neighbourhood of ſome of the iron mines.

SECT. CCLXX.

K. The Granites. *Saxum compoſitum feltſpato micâ et quartzo, quibus accidentaliter interdum hornblende, ſteatites, granatus et baſaltes immixti ſunt.*

Its principal conſtituent parts are feltſpat, or rhombic quartz, mica, and quartz: It is found

1. Looſe or friable, *Particulis conſtans parum coherentibus.*

    This is uſed at the braſs works to caſt the braſs in, and comes from France.

2. Hard and compact, *Granites durus.*

    a. Red.

    1. Fine-grained, from Swappawari at Tornea in Lapland

    2. Coarſe-grained, from Biſpbergs Klack, in the province of Dalarne.

    b. Grey, with many and various colours, found on the coaſt round Stockholm and Norland.

The

The Granites are feldom flaty or laminated, when their texture is clofe, and the harder particles, as the felt-fpat or rhombic quartz, the quartz, and the fhirl, predominate in it. They admit of a good polifh, for which reafon the Egyptians in former times, and the Italians now, work them into large pieces of ornamental architecture, for which purpofe they are extremely fit, as they do not decay in the air.

SECT. CCLXXI.

2. Conglutinated Saxa, *Saxa conglutinata.*

A. Of larger or broken pieces of ftones of the fame kinds conglutinated together, *Saxum conglutinatum fragmentis lapidum. Breccia.*

1. Of limeftone cemented by lime, *Saxum conftans fragmentis lapidis calcarei, calce conglutinatis.*

a. The calcareous Breccia, *Breccia calcarea:* The *Marmi Brecciati* of the Italians.

When thefe kinds have fine colours, they are polifhed and employed for ornaments in architecture, and other œconomical ufes; they come from Italy.

b. The *Lumachella* of the Italians, or fhell marbles. Thefe are a compound of fhells and corals, which are petrified or changed into lime, and conglutinated with a calcareous fubftance. When they have many colours, they are called

led Marbles, and employed for the ſame purpoſes as the preceding; likewiſe from Italy, from Bergen in Norway, and Offerdal in the province of Jemteland. In the iſland of Gottland there is found of this kind of one colour only, which on that account is not called Marble, or uſed as ſuch. At Balsberget, in the province of Skone, is found a white and yellow ſhell limeſtone, of weak colours.

SECT. CCLXXII.

2. Of kernels of jaſper cemented by a jaſpry ſubſtance, *Saxum fragmentis jaſpidis materiâ jaſpideâ conglutinatum. Breccia Jaſpidea. Diaſpro brecciato* of the Italians.

Of this kind ſpecimens from Italy are ſeen in collections. A coarſe Jaſper Breccia is ſaid to be found not far from Frejus in Provence in France.

SECT. CCLXXIII.

3. Of ſiliceous pebbles, cemented by a jaſpry ſubſtance, or ſomething like it, *Saxum ſilicibus amorphis materiâ jaſpideâ conglutinatis.* The plum-pudding ſtone of the Engliſh. *Breccia Silicea.*

Its baſis, which at the ſame time is the cement, is yellow, wherein are contained ſingle flinty or agaty pebbles, of a grey colour or variegated. This is of a very elegant appearance when cut and poliſhed; it is found in England.

SECT.

SECT. CCLXXIV.

4. Of quartzoſe kernels combined with an unknown cement, *Saxum fragmentis quartzoſis conglutinatis. Breccia quartzoſa.* Found in the provinces of Jemteland and Smoland.

SECT. CCLXXV.

5. Of kernels of ſeveral different kinds of ſtones, *Saxum fragmentis variorum ſaxorum conglutinatis. Breccia ſaxoſa.*

a. Of kernels of porphyry, cemented by a porphyry or coarſe jaſpry ſubſtance, *Breccia porphyrea,* from Serna Fiell, and Hykieberget in the province of Dalarne.

b. Of kernels of ſeveral ſaxa, *Saxum fragmentis variorum ſaxorum compoſitorum conglutinatis. Breccia indeterminata.*

Is found in looſe ſtones in Dalarne, and are originally broken from the Fiell tracts in Serna, which conſiſt of nothing elſe but conglutinated ſtones.

c. Of conglutinated kernels of ſandſtone, *Saxum fragmentis conſtans ſaxorum conglutinatorum. Breccia arenacea.*

This kind conſiſts of ſandſtone (Sect. cclxxvi.) kernels, which have been combined a ſecond time together. This is alſo found in looſe ſtones in Dalarne, and are perhaps originally broken

broken from the above-mentioned Fiell in Serna *.

SECT. CCLXXVI.

B. Conglutinated ſtones of granules or ſands of different kinds, *Saxum conglutinatum granulis ſeu arenâ variorum lapidum*. Sandſtone, *Lapis arenaceus*.

In this diviſion are reckoned thoſe which conſiſt of ſuch minute particles, that all of them cannot eaſily be diſcovered by the naked eye. The greateſt part, however, conſiſt of quartz and mica, which ſubſtances are the moſt fit to be granulated, without being brought to a powder.

I think I have reaſon to conſider this kind in regard to the ſubſtance which has ſerved as a cement to combine them, although it is not always perfectly diſcernible.

1. Cemented by clay, *Lapis arenaceus glutine argillaceo*.

* The above-mentioned Brecciæ of themſelves muſt demand the diſtinctions here made between them, but which perhaps may ſeem to be carried too far, ſince their particles are ſo big and plain, as to be eaſily known from one another. Theſe ſtones are a proof both of the ſubverſions which the mountains in many centuries have undergone, and of ſome hidden means which Nature makes uſe of in thus cementing different kinds of ſtones together. Any certain bigneſs for the kernels or lumps in ſuch compounds, before they deſerve the name of Breccia, cannot be determined, becauſe that depends on a compariſon, which every one is at liberty to imagine. At one place in the mountain called Hykieberget, the kernels of porphyry have a diameter of ſix feet, while in other places they are not bigger than walnuts. At Maſſewala the kernels have a progreſſive ſize down to that of a fine ſandſtone. Moſt of this kind of ſtone is fit for ornaments, though the workmanſhip is very difficult and coſtly.

a. With

a. With an apyrus or refractory clay, *Argillâ porcellaneâ.*

It is found under the ſtratum of coal in the coal-mine at Boſerup in Skone; is of a looſe texture, but hardens, and is very refractory in the fire.

b. With common clay, *Argillâ communi*, from Burſwick in the iſland of Gottland.

2. With lime, *Lapis arenaceus glutine calcareo*; reſembles mortar made with coarſe ſand.

a. Conſiſting of tranſparent and greeniſh grains of quartz and white limeſtone; from the iſland Iſo, near Beckaſkog in Skone.

b. Of no viſible particles, from France and Livonia. This is of a looſe texture, and hardens in the air.

3. With an unknown cement, *Lapis arenaceus glutine incognito, forſan argillaceo.*

a. Looſe, from Helſingberg in Skone.

b. Harder, from Roſlagen, Orſa, and Kinnekulle.

c. Compact, from Geſle in the province of Geſtrikeland, and the lake Malaren.

d. Very hard, from Serna Fiell or Fells in Dalarne; it is alſo found in great abundance in looſe ſtones at Guſtavsſtrom, and at Siliamfors in the pariſh of Mora in Dalarne.

4. Cemented by the ruſt or ochre of iron, *Lapis arenaceus ochrâ martis conglutinatus.* Is found in form of looſe ſtones at ſeveral places, and ought perhaps to be reckoned among

among the *Mineræ Arenaceæ* or Sand-Ores; (Sect. cclxxvii.) at least when the martial ochre makes any considerable portion of the whole *.

SECT. CCLXXVII.

C. Stones and ores cemented together, *Saxum fragmentis constans lapidum et minerarum conglutinatis. Mineræ Arenaceæ.*

1. Of larger fragments, *Fragmentis lapidum et minerarum majoribus.*

   a. Mountain green, or *Viride Montanum Cupri*, and pebbles cemented together, from Siberia.

* Sandstones are of great use in œconomy, as materials for buildings which resist fire, air, and water, are made of them. Some of them are soft while in the quarry, but harden in the open air. The loose sandstones are the most useful; but the solid and hard ones, such as *c.* and *d.* crack in the fire, and take a polish when used as grindstones. However, though the Burswik's stone, (1. *b.*) is pretty loose in its texture, it is nevertheless unfit for buildings which are exposed to fire or open air, because it breaks to pieces and melts in the fire, and in the air it attracts the moisture, decays in length of time, and cracks in the cold, which proceeds from the included kernels of clay expanding themselves when they grow wet; the sandstones ought therefore to be very nicely examined before they are employed to the usual purposes.

There are many quarries of sandstones in Sweden, but no enquiry has yet been made if any of them, and which, can be employed in the larger works, instead of the English, and in the smaller manufactories instead of the Bohemian sandstones. Such enquiries are of greater consequence, in proportion as those manufactures encrease wherein they are wanted. It must be remarked, that the working-masons or stone-cutters ought to wear a piece of frieze or baize before their mouth and nose, in order to preserve themselves from a premature death, which now-a-days unhappily is the case with them in the parish of Orsa in Dalarne, and in other places; but limestone is not found to have this bad effect.

 b. Potters

b. Potters lead ore, with limeſtone, ſlate-kernels and ſhells, from Gragruſvan at Boda in Rettwik, and in Dalarne.

c. Yellow or marcaſitical copper ore, with ſmall pebbles.

SECT. CCLXXVIII.

2. Of ſmaller pieces, *Granulis lapidum et minerarum*.

a. Potters lead ore with a quartzoſe ſand, from Eiffelsfeldt near Cologn in Germany.

b. Mountain green with ſand, from Siberia.

c. Cobalt ore with ſand.

d. Martial ochre with ſand *.

SECT. CCLXXIX.

Observations on the Saxa or Stones.

Beſides the advantages which may accrue to œconomy by a perfect knowledge of the Saxa, the miners or ſubterranean geographers expect alſo another

* The *Mineræ Arenaceæ* or Sand-ores, cannot reaſonably be ſeparated from the ſand-ſtones, ſince they are produced in the ſame manner ; beſides, when they are poor in yield, they are alſo employed to the ſame purpoſe, becauſe it is not eaſy to ſmelt the metal out of them. The ſand-ores, beſides, cannot be ranked in a mineral ſyſtem as ſeparate ſpecies of ores, becauſe they would then be arranged with reſpect to the kind of ſtone in which the ore occurs, and not the ore itſelf, which caſe cannot be admitted here. It might be urged, that ores, mixed with the ſtones of the very load, and not in form of ſand-ores, ought as well as them to be ranked among the compound ſaxa ; but in that caſe there would be no end of ſpecies, nor could they ever be reduced into any order.

another future benefit from it, viz. that of concluding, from many obſervations, if all the Saxa are to be equally conſidered; for example, if in ſome of them veins or ſtrata of ores may be expected, and if thoſe are only of certain kinds; if others are every where found deſtitute of any ore whatſoever; if, and which of them are fit to form coats on the ſurface of the rock, which covers other kind of ſtones, and alſo veins and ſtrata of ores, &c. If no general rules are to be deduced from ſuch obſervations, there is a probability, at leaſt, to gain ſome inlights that may be particular to certain countries; and this opinion is already in ſome places confirmed by experience. Hence it may be concluded, how neceſſary it is to communicate all ſuch obſervations which, for the above-mentioned purpoſes, ought to be made over the whole globe, and to agree on fixing certain names on the *Saxa*, in order to avoid too great a prolixity in their deſcriptions. It is with this intention I have here, as a trial, given ſpecific names to thoſe Saxa which are found in this northern country, and which Saxa I know; wiſhing at the ſame time to be acquainted with a method to diſtinguiſh them more eaſily and to better purpoſe.

This procedure will be found ſtill more neceſſary and uſeful, as the world ſeems reſolved ſoon to aboliſh the ſuperſtition of the Hazel Rod or *Virgula Divinatoria*, and that we have by means of obſervations already got too much experience to believe, that the ſtrata of earths and ſtones are placed equally and in the ſame order and ſituation over the whole earth; which ſome, however, in theſe our times have even endeavoured to prove, while others have made a ſecret of it, in order by ſome way or other to enrich themſelves.

SECT. CCLXXX.

The SECOND ORDER.

MINERAL-CHANGES, or the PETREFACTIONS.

Mineralia-Larvata, vulgò *Petrefacta*,

Are mineral bodies in the form of animals or vegetables, and for this reason no others belong to this order, than such as have been really changed from the subjects of the other two kingdoms of nature.

There is more difficulty to determine the first point, viz. from when these bodies are to be stiled petrefactions, than from when they cease to be such; meanwhile I have, in order to make a trial, considered them in the following manner.

SECT. CCLXXXI.

1. Earthy Changes, *Terræ Larvatæ. Terrificata.*
   A. Extraneous bodies changed into a lime substance, or calcareous changes, *Larvæ calcareæ.*
      1. Loose or friable. Chalky changes, *Cretæ larvatæ.*
         a. In form of vegetables.
         b. In form of animals.
            1. Calcined or mouldered shells, *Humus conchaceus*, from the province of Helsingeland, at Uddevalla in the province of Halland, and in the French strata of earth and chalk.
      2. Indurated, *Petrefacta calcarea.*

a. Changed

a. Changed and filled with ſolid limeſtone.
1. In form of animals.
2. In form of vegetables.
Found in the iſland of Gottland.

b. Changed into a calcareous ſpar, *Petrefacta calcarea ſpatoſa.*
1. In form of animals.
The ſhells in Balſberget in the province of Skone.
2. In form of vegetables *.

SECT. CCLXXXII.

B. Extraneous bodies changed into a flinty ſubſtance. Siliceous changes, *Larvæ ſiliceæ.* Theſe are like the flint,
1. Indurated, *Petrefacta ſilicea.*
a. Changed into flints.

* Shells and corals are indeed compoſed of limy matter, even when their animals ſtill dwell in them; nevertheleſs, although they are not changed in regard to their principle, yet are they reckoned among the petrefactions, as ſoon as the particles of the calcareous ſubſtance have got a new ſituation; for example, when they are become ſparry, when they have been filled with a calcareous earth, either hardened or looſe, or when they lie in the ſtrata of the earth. Theſe form the greateſt part of foſſil collections, which are ſo induſtriouſly made, often without any regard to the only and principal uſe they can be of, viz. that of enriching zoology. Mineraliſts are ſatisfied with ſeeing the poſſibility of the changes the limeſtone undergoes in regard to its particles, and alſo with receiving ſome inlight into the alterations which the earth has been ſubject to, from the ſtrata which are now found in it.

The calcined ſhells, or thoſe which have been changed into limy and chalky matter, are fit to make lime, and are ſtill more ſerviceable as a manure. The indurated ſerve only to make grottos. No gypſeous petrefactions are known, if ſuch are not found in the Perſian alabaſter; for Mr. Chardin ſays, that he has ſeen a lizard included in that ſtone.

1. Carnelians in form of ſhells, from the river Tomm in Siberia.
2. Agat in form of wood. Such a piece is ſaid to be in the collection of Count Teſſin.
3. Coralloids of white flint, (*Millepora*) found in Gottland.
4. Wood of yellow flint. Italy, Adrianople, and Loughneagh, a lake in Ireland.

SECT. CCLXXXIII.

C. Extraneous bodies changed into clay. Argillaceous changes, *Larvæ argillaceæ.*

a. Looſe and friable.

1. Of porcellane clay.

a. In form of vegetables.

A piece of white porcellane clay from Japan, with all the marks of the root of a tree, has been obſerved in a certain collection.

b. Indurated.

1. In an unknown clay.

a. In form of vegetables. *Oſteocolla.* It is ſaid to be changed roots of the poplar tree, and not to conſiſt of any calcareous ſubſtance. See the *Phyſicaliche Beluſtigungen.*

A ſort of foſſil ivory is ſaid to be found, which has the properties of a clay; but I do not know if it is rightly examined.

SECT. CCLXXXIV.

2. Saline extraneous bodies, or ſuch as are penetrated by mineral ſalts, *Corpora peregrina inſalita. Larvæ inſalitæ.*

A. With the vitriol of iron, *Vitriolo martis inſalita.*

1. Animals.

a. Human bodies have been twice found in the mine at Falun in Dalarne; the laſt was kept a good many years in a glaſs caſe, but began at laſt to moulder and fall to pieces.

2. Vegetables.

a. Turf, and

b. Roots of trees.

These are found in water ſtrongly impregnated with vitriol; for inſtance, in the moor at Oſterſilfberget in Dalarne. They do not burn with a flame, but only like a coal in a ſtrong fire; neither do they decay in the air.

SECT. CCLXXXV.

3. Extraneous bodies penetrated by mineral inflammable ſubſtances, or mineral phlogiſton, *Corpora peregrina phlogiſtis mineralibus impregnata.*

A. Penetrated by the ſubſtance of pit-coals, *Lithantrace impregnata.*

1. Vegetables, which commonly have been woods, or appertaining to them.

a. Fully ſaturated. *Gagas. Jet.*

The jet is of a ſolid ſhining texture. From England, Boſerup in Skone, and the Black Sea.

b. Not perfectly ſaturated. *Mumia vegetabilis.* Is looſe, reſembles umbre, and may be uſed as ſuch. From Boſerup.

SECT. CCLXXXVI.

B. Penetrated by rock oil or aſphaltum, *Corpora peregrina petroleo ſeu aſphalto impregnata.*

1. Vegetables.

a. Turf, in the province of Skone.

The Egyptian mummies cannot have any place here, ſince art alone is the occaſion that thoſe human bodies have in length of time been penetrated by the aſphaltum, in the ſame manner as has happened naturally to the wood in pit-coal ſtrata (Sect. cclxxxv. *b*).

SECT. CCLXXXVII.

C. Penetrated by ſulphur which has diſſolved iron, or by marcaſite and pyrites, *Pyrite impregnata. Petrefacta pyritacea.*

1. Human.

a. Bivalves,

b. Univalves, and

c. Inſects.

In the alum ſlate at Andrarum in Skone.

SECT.

SECT. CCLXXXVIII.

4. Metals in the form of extraneous bodies, *Larvæ metalliferæ.*

A. Silver, *Larvæ argentiferæ.*

1. Native.

a. On the ſurfaces of ſhells. England.

2. Mineraliſed with copper and ſulphur.

a. Fahlertz or grey ſilver ore (Sect. clxxi.) in form of ears of corn, &c. and ſuppoſed to be vegetables, are found in argillaceous ſlate at Frankenberg and Tahlitteren in Heſſe.

SECT. CCLXXXIX.

B. Copper, *Larvæ cupriferæ.*

1. Copper in form of calx, *Cuprum calciforme corpora peregrina ingreſſum.*

a. In form of animals, or of parts belonging to them.

1. Ivory, and other bones of the elephant. The Turcois or Turky ſtone. It is of a blueiſh green colour, and much valued in the Eaſt.

At Simore in Languedoc bones of animals are dug, which during the calcination aſſume a blue colour; but it is not probable that the blue colour is owing to copper.

SECT. CCXC.

2. Mineraliſed copper, which impregnates extraneous bodies, *Cuprum mineraliſatum corpora peregrina ingreſſum.*

A. With

A. With sulphur and iron. The yellow or marcasitical copper ore that impregnates

1. Animals.

   a. Shells, from Hagatienns Schurff and Jarlsberg in Norway. These shells lye upon a loadstone,

   b. In form of fish, from Eeisleben, Mansfeld, and Osterode, in Germany.

B. With sulphur and silver. Grey silver ore or Fahlertz, like ears of corn, from the slate quarries in Hesse (Sect. cclxxxviii.).

SECT. CCXCI.

C. Changes into iron, *Larvæ ferriferæ*.

1. Iron in form of calx, which has assumed the place or the shape of extraneous bodies, *Ferrum calciforme corpora peregrina ingressum*.

   a. Loose, *Larvæ ochraceæ*.

   1. Of vegetables.

      Roots of trees, from the lake Langelma in Finland: See the Acts of the Swedish Academy of Sciences for the year 1742.

   b. Indurated, *Larvæ hæmatiticæ*.

   1. Of vegetables.

      Wood, from Orbissau in Bohemia.

SECT. CCXCII.

2. Iron mineralised, assuming the shape of extraneous bodies, *Ferrum mineralisatum*

mineralisatum corpora peregrina ingressum.

a. Mineralised with sulphur. Marcasite. *Larvæ Pyritaceæ.* Sect. cclxxxvii.

SECT. CCXCIII.

5. Extraneous bodies decomposing, or in a way of destruction, *Corpora peregrina in gradibus destructionis considerata.* Mould, *Humus.* Turf, *Turba.*

A. From animals. Animal mould, *Humus animalis.*

1. Shells. *Humus conchaceus.*
2. Mould of other animals, *Humus diversorum animalium.*

B. Vegetable mould, *Humus vegetabilis.*

1. Turf, *Turba.*

a. Solid, and hardening in the air, *Turba solida aëre indurescens.* Is the best of this kind to be used for fuel, and comes nearest to the pit-coals. It often contains a little of the vitriolic acid.

b. Lamellated turf, *Turba foliata.* This is in the first degree of destruction.

2. Mould of lakes, *Humus lacustris.* This is a black mould which is edulcorated by water.
3. Black mould, *Humus ater.*

This is universally known, and covers the surface of that loose earth in which vegetables thrive best *.

* All the kinds of mould contain some of the inflammable substance, which has remained in them from the vegetables or animals; and they are more or less black, in proportion as they contain

SECT. CCXCIV.

The THIRD ORDER.

NATURAL SLAGS,

Scoriæ Vulcanorum.

Slags are found in great abundance in many places in the world, not only where volcanos yet exist, but likewise where no subterraneous fire is now known: Yet, according to our opinion, they cannot be produced but by means of fire. These are not properly to be called natural, since they have marks of violence, and of the last change that mineral bodies can suffer without the destruction of the world; nor are they artificial, according to the universally received meaning of this word. When we perhaps in future times by new discovered means may be able to find out of what sort of earth stones are compounded, we shall still be forced to stop at the surface of them, and be contented with knowing that they contain a little iron. Mean while I cannot omit them here, since I have considered the petrefactions; and therefore I will enumerate some of them, according to their external marks.

contain more or less of this phlogiston. I have ranked them in this place, that they might not be totally excluded. They are else a *medium uniens* between all the three kingdoms of nature: And it may reasonably be asked, if all sorts of earth do not in form of very minute particles enter into the composition of vegetables and animals, after which they exist for some time in form of mould, until the phlogiston is again separated.

SECT. CCXCV.

A. Iceland agat, *Achates islandicus niger.*

It is black, solid, and of a glassy texture; but in thin pieces, it is greenish and semi-transparent like glass bottles, which contain much iron. The most remarkable is, that such large solid masses are found of it, that there is no possibility of producing the like in any glasshouse.

It is found in Iceland, and in the Island of Ascension: The jewellers employ it as an agat, though it is too soft to resist wear.

SECT. CCXCVI.

B. Rhenish millstone, *Lapis molaris Rhenanus.*

Is blackish grey, porous, and perfectly resembles a sort of slag produced by Mount Vesuvius. If I am mistaken in this, I hope that somebody else will describe the constituent parts of this millstone.

SECT. CCXCVII.

C. Pumice-stone, *Pumex.*

Is very porous and blistered, in consequence of which it is specifically very light. It resembles that froathy slag which is produced in our iron furnaces.

1. White.
2. Black.

The colour of the first is perhaps faded or bleached, because the second kind comes in that state from the laboratory itself, viz. the volcanos.

SECT.

SECT. CCXCVIII.

D. Pearl flag, *Scoriæ constantes globulis vitreis conglomeratis.*

Is compounded of white and greenifh glafs particles, which feem to have been conglutinated while yet foft, or in fufion. Found on the Ifle of Afcenfion.

SECT. CCXCIX.

E. Slag-fand or afhes, *Scoriæ pulverulentæ. Cineres Vulcanorum.*

This is thrown forth of the volcanos in form of larger or fmaller grains. It may perhaps be the principle of the Terra Puzzolana (Sect. ccix. *a.*), becaufe fuch an earth is faid at this time to cover the ruins of Herculaneum near Naples, which hiftory informs us was deftroyed by a volcano during an earthquake.

SECT. CCC.

Observations on the preceding Slags.

It feems as if we could not go any farther in the arrangement of bodies belonging to the mineral kingdom, than to the black mould (Sect. ccxciii.) and the flags, as being the extremes.

However, if thefe flags likewife decay, and in length of time become an earth, which poffibly may happen; there is then a new fubftance beyond them, which however may return back and circulate again in fome known form. It is obvious how the old heaps of flags from the iron furnaces

furnaces decay, and at laſt produce vegetables, which cannot be aſcribed to a black mould alone carried thither by the wind. The ſame may perhaps happen with the natural ſlags in the open air; but we do not know if it is ſo, nor what different forms this and every other earth which circulates in animals and vegetables further aſſumes: However, in ſuch circumſtances, as their particles become or are already very minute, and moſt part of the phlogiſton becomes volatile, when acted upon by heat or fire, it ſeems probable, that, by a ſlow ſeparation of the phlogiſton, or a union by means of ſalts, this earth is moſt apt to become a clay, provided it is not by any previous revolution laid in ſuch places as to change it into ſlate, pit-coal, &c.

If at any time it ſhould happen that a volcano ſhould burſt out of a mountain, whoſe ſtrata we knew before, we could at leaſt imagine ſome reaſons for this wonderful effect: However, the learned would nevertheleſs, perhaps, want ſome knowledge about the ſubſtances of the ſtrata, and the manner of their formation; ſince in this circumſtance water and other obſtacles have hindered people too much from making the due obſervations thereon.

Meanwhile, the more we conſider, on the one part, all the modifications and alterations the earths undergo by means of fire and water, by the free or impeded acceſs of the air, by the volatility and attraction of the acid ſalts, whereby are produced ſolution and hardening, compoſition and ſeparation; and, on the other part, reflect on the ſhortneſs of a man's life, perhaps alſo dedicated to other buſineſs, on the difficulty of obſerving the ſubterraneous effects, and on ſeveral other things, which prevent the making diſcoveries, by which we might find out ſome eaſier means to attain true knowledge

knowledge by judicious experiments; the more we ſhall find, what is wanted to form mineral ſyſtems, and for this reaſon be apt to excuſe the faults of thoſe which have been hitherto publiſhed.

From thoſe, who of themſelves are ſuſceptible of theſe ſentiments, I ſuffer with pleaſure that judgment, which I am myſelf ready to pronounce upon this Eſſay,

Tranſeat cum ceteris.

F I N I S.

DESCRIP-

DESCRIPTION and USE

OF A

Mineralogical Pocket Laboratory;

AND ESPECIALLY THE

USE of the BLOW-PIPE

IN

MINERALOGY.

By GUSTAV VON ENGESTROM.

T

DESCRIPTION

OF A

Mineralogical Pocket Laboratory, &c.

SECT. I.

THAT Science which teaches us the properties of mineral bodies, and by which we learn how to characterize, diſtinguiſh, and claſs them into a proper order, is called *Mineralogy*. This, like all other ſciences, when rightly cultivated, and employed to its proper end, (the Public Good) furniſhes us with many uſeful diſcoveries, in proportion as it increaſes.

SECT. II.

Mineralogy has been ſtudied for ſeveral ages, yet its progreſs has been very ſlow.

Some learned men have, indeed, endeavoured to bring it into ſome ſyſtematical order: But as the paſſion for only collecting minerals and foſſils has ſtill predominated over that of diving into the nature of the ſubjects themſelves, they have for the moſt part met with but very little ſucceſs. Thoſe who were *mere Collectors*, being ſuperior in number to the *ſcientifical ones*, or *Mineraliſts*, and

 having

having more opportunities of getting new ſpecimens, were moſt of them not ſo communicative to the latter as they ought to have been. Some of theſe, fond of the number, were wholly taken up in gathering together immenſe heaps of things, ſeeming almoſt reſolved to get the whole of Nature into their cabinets, without having regard to any true order; while others, purpoſing to correct this inconveniency, would pretend to ſome interior knowledge, as if that had been a conſequence of their collection; and by that fell into another ſtill greater extravagancy.

All this certainly hindered the mineraliſts from improving much in the ſcience; but, happily, thoſe times are paſt. The world is grown more reaſonable at preſent, and Mineralogy ſeems more and more to be encouraged.

The great utility of the mineral bodies already known, promiſes us a greater advantage from the ſtudy of this ſcience, than only the pleaſure of collecting. But, in order to come at this advantage, we ought to ſearch into the very principles of theſe bodies, that we may be certain of not deceiving ourſelves in our judgment about them.

SECT. III.

As the principal end of cultivating Mineralogy is to find out the œconomical uſe of the minerals, it is neceſſary to know every occurrent mineral body in regard to all its effects; from them to determine the beſt uſe it might be put to. A Syſtem of Mineralogy thus founded on the effects of its ſubjects, muſt be more ſcientifical, ſince it always has in view that real point, *their application to Common Life:* And ſince it is natural to the human mind to adapt every thing to its own advantage,

vantage, as far as poſſible, ſuch a ſyſtem muſt be more generally received, and at the ſame time the eaſier underſtood, as it includes the mineral bodies in a leſs number of claſſes, orders, &c. by which the memory is not ſo much clogged, as if only their ſurfaces had been deſcribed.

SECT. IV.

This granted, let us conſider what difficulties there are to be met with in examining mineral bodies. Theſe are often like one another as to their external appearances, although their conſtituent parts are quite different, and conſequently make them uſeful in different ways: Moſt part of them ought alſo to be changed from their natural form, and even often diſſolved, before they can be made any uſe of. Their figure and colour, or, in ſhort, their ſurfaces, are therefore not ſolely to be depended upon; we muſt penetrate into them; and they muſt be decompounded according to the principles of chemiſtry.

SECT. V.

By examining the mineral kingdom in this manner, we may now and then find the ſubjects of our experiments (if even nearly the ſame) to differ in ſome of their effects, which is particularly owing to the difficulty of juſtly determining the degrees of the fire employed; a difficulty not yet removed, but which, however, ought not to hinder us from going as far as poſſibly we can, ſince we find by practice, that ſuch obſtacles often are remedied by repeated experiments; and of theſe we never can make too many, if judiciouſly performed.

SECT. VI.

This way of ſtudying Mineralogy has already ſome time ago been entered upon; but Mr. Pott, at Berlin, has brought it to a greater perfection; and after him Mr. Cronſtedt, in Sweden, has extended it yet farther, ſubmitting every mineral body, that came to his hands, to chemical experiments; in conſequence of which he afterwards publiſhed his *Eſſay towards a Syſtem of Mineralogy*.

SECT. VII.

Thus the greateſt obſtacle is removed; the beſt method to learn Mineralogy is laid open, in following which we are enabled to render this Science more and more perfect. To obtain this end, chemical experiments are without doubt neceſſary; but as a great deal of the mineral kingdom has already been examined in this manner, we do not want to repeat all thoſe experiments in their whole extent, unleſs ſome new and particular phœnomena ſhould diſcover themſelves in thoſe things we are examining; elſe the tedíouſneſs of thoſe proceſſes might diſcourage ſome from going farther, and take up much of the time of others, that might be better employed. An eaſier way may therefore be made uſe of, which even for the moſt part is ſufficient, and which though made in miniature, yet is as ſcientifical as the common manner of proceeding in the laboratories, ſince it imitates that, and is founded upon the ſame principles. This conſiſts in *a method of making experiments upon a piece of charcoal with the concentrated flame of a candle blown through a Blow-pipe*. The heat

fig. 4.

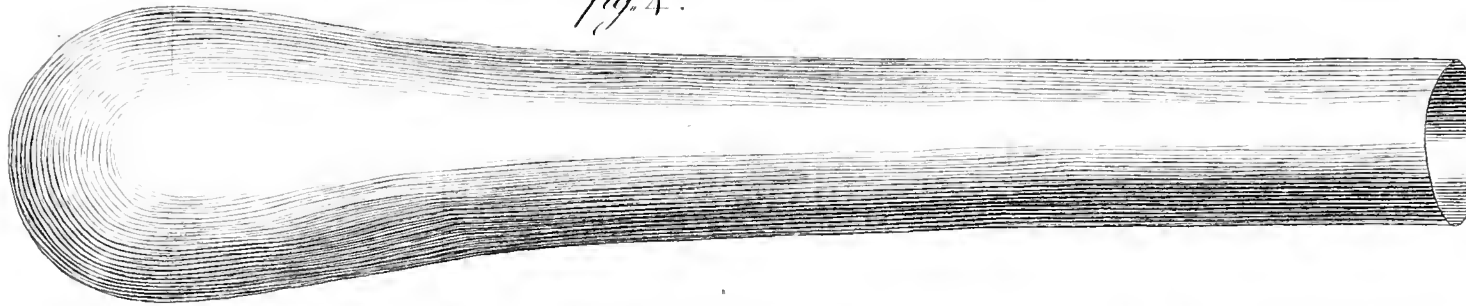

fig. 3.

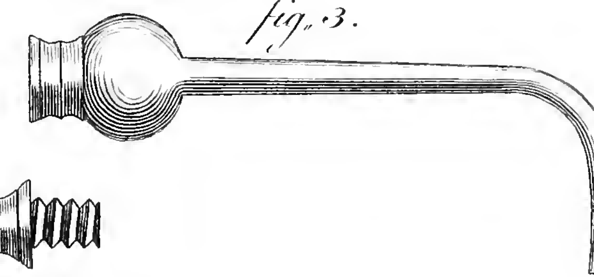

fig. 2.

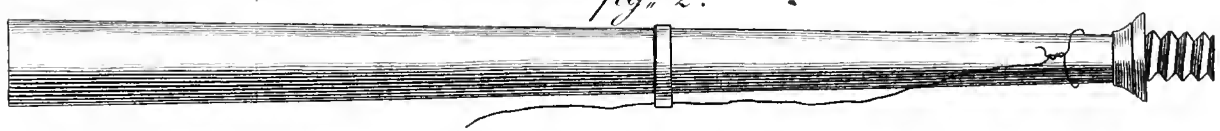

fig. 1.

fig. 5.

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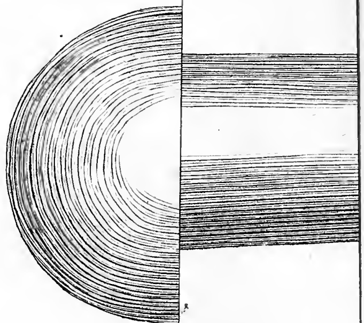

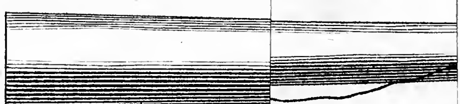

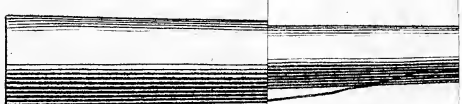

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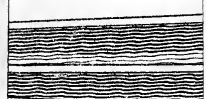


heat occaſioned by this, is very intenſe, and the mineral bodies may here be burnt, calcined, melted, or ſcorified, &c. as well as in any great works.

SECT. VIII.

The Blow-pipe is in common uſe among jewellers, goldſmiths, ſome glaſs-blowers, &c. and has even been uſed a little by the chemiſts and mineraliſts; but, to the beſt of my knowledge, Mr. Cronſtedt is the firſt who made ſuch an improvement in its uſe, as to be employed in examining all mineral bodies. This gentleman invented ſome other apparatus, neceſſary in making the experiments, to go with the Blow pipe, which all together make a neat little caſe, that, for its facility of being carried in the pocket, particularly on travels, might be called a *Pocket-Laboratory*: And as neither this Pocket Laboratory, nor even the extenſive uſe of the Blow-pipe, is yet generally known, I think it will not be altogether uſeleſs, to give a deſcription of it.

SECT. IX.

The Blow-pipe is repreſented in its true figure and ſize, Tab. 1, fig. 1. The globe *a* is hollow, and made on purpoſe to condenſe the vapours, which always happen to be in the Blow-pipe when it has been uſed ſome time: If this globe was not there, the vapours would go directly with the wind out into the flame, and would thereby cool the aſſay.

The hole in the ſmall end *b*. through which the wind comes out, ought not to be larger than the ſize of the fineſt wire. This hole may now and then be ſtopped up with ſomething coming into it, which hinders the force of the wind; one ought therefore to have a piece of the fineſt wire, to clear it with when required: And, in order to have this wire the better at hand, it may be faſtened round the Blow-pipe, in ſuch a manner as is repreſented in fig. 1. *c* is the wire, faſtened round the Blow-pipe at *d.* and afterwards drawn through a ſmall hole at *e.* made in the ring *f.* to keep it more ſteady.

SECT. X.

The Blow-pipe is compounded of two parts, Tab. 1. fig. 2. and 3; and this for the facility both of making, carrying it along, and cleaning it on the inſide when it is wanted.

In order to determine the moſt convenient proportions of this inſtrument, ſeveral Blow-pipes of different ſizes, both bigger and ſmaller, have been tried: The former have required too much wind, and the latter being too ſoon filled with the wind, have returned it back again upon the lungs: Both theſe circumſtances hindered greatly the experiments, and are perhaps even prejudicial to the health. This ſize, fig. 1, is found to anſwer beſt; and though the hole muſt be as ſmall as before mentioned (Sect. ix.) yet the ſides of the pipe at the point muſt not be thinner, nor the point narrower than here repreſented, elſe it will be too weak, and will not give ſo good a flame. It is alſo to be obſerved, that the canal throughout the pipe, but particularly the hole at the ſmall end, muſt be made very ſmooth, ſo that there are no inequalities in it; the wind would elſe be divided, and conſequently the flame made double. That Blow-pipe is to be reckoned the beſt, through which can be formed the longeſt and moſt pointed flame from off a

common-

fig. 1.

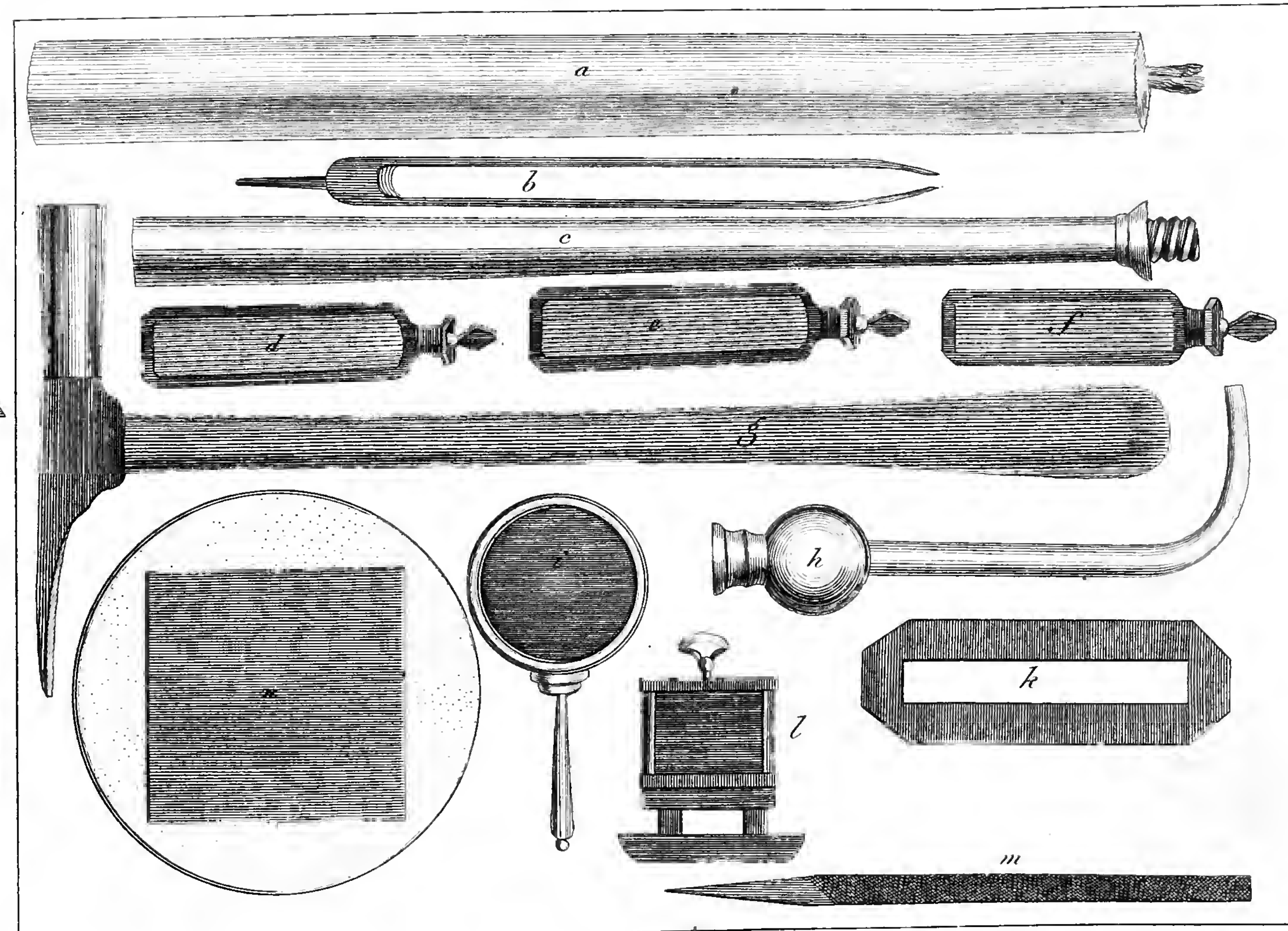


fig. 4.

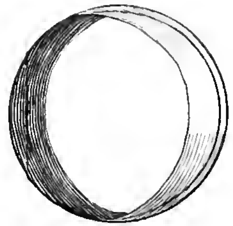


fig. 3.

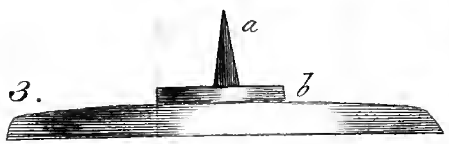
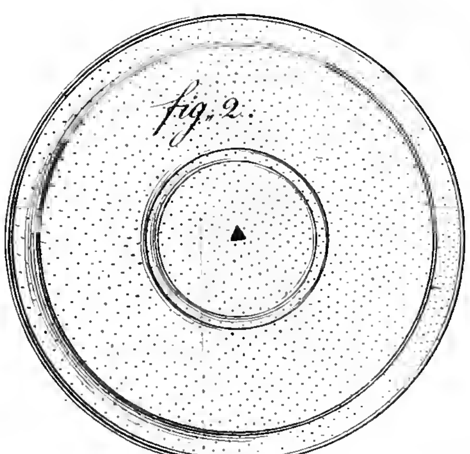


fig. 2.



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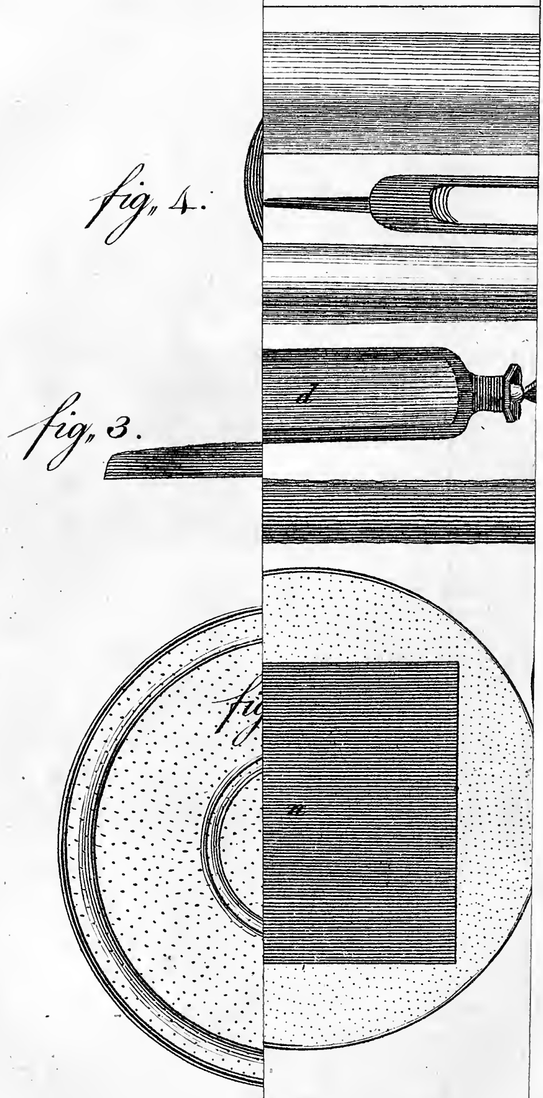
fig. 4.
fig. 3.
d
n

common-ſized candle. Theſe Blow-pipes are commonly made of braſs or ſilver.

SECT. XI.

The whole Pocket-Laboratory is repreſented Tab. II. fig. 1, with the caſe, exactly of the form, bigneſs, and proportions as that I make uſe of myſelf: What alterations there may be wanted are eaſily found out by practice.

c b are the two parts of which the Blow-pipe conſiſts, and which are already deſcribed.

a. a wax-candle, deſtined to be made uſe of, particularly in travels, when no other candle is to be had.

b. a pair of nippers, *(Korntong)* to handle ſo much the eaſier the things which are to be tried, becauſe they are generally ſmall particles: This ſerves alſo to touch and turn the ſubjects during the experiments, when they are hot, and could not be well handled with the fingers.

d. e. f. are three phials, to put the required fluxes in, viz. Borax, the Mineral Alcali *(Sal Sodæ)*, and *ſal fuſibile microcoſmicum.*

g. a hammer, to break any part of a ſtone, when it is to be tried: This ſerves alſo to pound things with.

i. A magnifying glaſs, neceſſary when the objects are too ſmall to be ſeen by the naked eye.

k. a ſteel, to ſtrike fire, by which the hardneſs or ſoftneſs of the bodies is tried.

l. a loadſtone, to diſcover the preſence of iron.

m. a file, wherewith to diſtinguiſh natural gems, quartz-criſtals, and artificial or coloured glaſſes from one another.

n. a thin ſquare plate made of untempered ſteel, filed flat on one ſide, to pound things upon, and poliſhed polifhed on the other fide, to hammer metals upon.

Above this fteel plate *n.* and within the circle, drawn round about it, is the place for a candleftick. This candleftick is fhewn in plan, fig. 2, and in profile, fig. 3, Tab. II. It confifts of a round brafs plate; the point *a.* and the ring *b.* round it, is inftead of the focket in another candleftick, which would here take up too much room.

Fig. 4, (Tab. II.) is a thin iron ring, a fixth part of an inch high; within this ring the pounding and grinding of the things upon the fteel plate fig. 1, *n.* is performed, that they may not be loft. In packing up, this ring is to be put loofe upon the candleftick; and, as it is lower than the point of this, it does not take up much room in the cafe.

The whole cafe, thus made, with all the inftruments in it, as I have defcribed them, is no more than one and an eighth part of an inch high, and confequently not more troublefome to be carried in the pocket than a fmall book *.

* The *Pocket Laboratory* here defcribed, and the *Box for the Acids*, mentioned in Sect. lxii. have been improved after the manner of Mr. Cronftedt, by a gentleman particularly acquainted with Mr. Engeftrom, from whom he learned this method of making Mineralogical Experiments. The bulk of the firft has been reduced nine and a half cubic inches; its length being diminifhed *one* fixteenth of an inch, the breadth *five* ditto, and the depth *two*; notwithftanding which, there is alfo added a piece of charcoal for trying the experiments, a flint, a piece of agaric tinder, and fome matches for lighting the candle. The three phials *d e f* for the falts, are of different colours, to prevent any miftake. The candleftick *s* has different concentric grooves for keeping the refults of the trials feparate. The blow-pipe *c b* has a filver mouth-piece, and fcrews in the middle of the ball, in order to clean out the moifture with the greater eafe; and the fmall wire [Sect. ix.] is more conveniently detached than fixed round it. The other box for

SECT. XII.

Whenever any thing is to be tried, one muſt not begin immediately with the Blow-pipe; ſome preliminary experiments ought to go before, by which thoſe in the fire may afterwards be directed. For inſtance, a ſtone is not always homogeneous, or of the ſame kind throughout, although it may appear to the eye to be ſo: The magnifying-glaſs is therefore neceſſary, to diſcover the heterogeneous particles, if there be any; and theſe ought to be ſeparated, and every thing tried by itſelf, that the effects of two different things, tried together, may not be attributed to one alone. This might happen with ſome of the finer *micæ*, which are now and then found mixed with ſmall particles of quartz, ſcarcely to be perceived by the eye. The Trapp, (in German *Schwartzſtein*) is alſo ſometimes mixed with very fine particles of Feltſpat (*ſpatum ſcintillans*) or of Calcareous Spar, &c. After this experiment follows that, to try the hardneſs of the ſtone in queſtion with the ſteel. The Flint and Garnet-kinds are commonly known to ſtrike fire with the ſteel; but there are alſo other ſtones, though very ſeldom, found ſo hard as to ſtrike fire:

for the acids, mentioned Sect. lxii. is reduced to leſs than a fourth of its original bulk, being exactly of the ſame ſize with the above. It contains two ſmall matraſſes [Tab. I. fig. 4.] for making ſolutions; a trough [Tab. I. fig. 5.] for waſhing the ore after its being pounded; and the three ſmall bottles with double ſtoppers, for the *nitrous*, *muriatic*, and *vitriolic* Acids, have their reſpective initials cut on each.

Both theſe Pocket-Laboratories, made in the neateſt manner by an ingenious artiſt, may be had ready furniſhed with the pureſt acids, &c. at the *General Office of Buſineſs, Arts and Trade*, opened for the preſent at No. 98, Wood-Street, Cheapſide, and only there, for very reaſonable prices.

A kind of Trapp is found of that hardneſs, in which no particles of Feltſpat are to be ſeen. Coloured glaſſes reſemble true gems; but as they are very ſoft in proportion to theſe, they are eaſily diſcovered by the means of the file: The common quartz-cryſtals are harder than coloured glaſſes, but ſofter than the gems. The loadſtone diſcovers the preſence of iron, when it is not mixed in too ſmall a quantity in the ſtone, and often before the ſtone is roaſted. Some kinds of *Hæmatites*, and particularly the *Cœruleſcens*, is very like ſome other iron ores, but diſtinguiſhes itſelf from theſe by a red colour, when pounded, the others giving a blackiſh powder, and ſo forth.

SECT. XIII.

To manage the Blow-pipe with eaſe requires ſome practice. A beginner blows generally too ſtrongly, which forces him to take breath very often, and then he draws the flame at the ſame time along into the Blow-pipe: This is troubleſome for himſelf, and the experiment cools always a little at the ſame time. But the more experienced can breathe in, through the noſe, and yet at the ſame time blow through the pipe, whereby a conſtant flame from the candle is kept up. The whole art conſiſts in conſtantly taking in air through the noſe, and with the tongue moderating its blowing out; ſo that the tongue performs nearly the office of a ſucker in a pump; or rather, the action of the noſe, lungs, and mouth, reſembles here the action of bellows with double partitions. In this manner there is no need of blowing violently, but only with a moderate and equal force, and thus the breath can never fail the operator. The only inconveniency attending, is, that the

the lips grow weak or tired, after having continued to blow for a while in one ſtrain; but they ſoon recover their former ſtrength, by ceaſing to blow for ſome minutes.

SECT. XIV.

The candle uſed for this purpoſe (Sect. vii.) ought to be ſnuffed often, but ſo, that the top of the wick may retain ſome fat in it, becauſe the flame is not hot enough when the wick is almoſt burnt to aſhes; but only the top muſt be ſnuffed off, becauſe a low wick gives too ſmall a flame. The blue flame is the hotteſt; this ought therefore to be forced out when a great heat is required, and only the point of the flame muſt be directed upon the ſubject which is to be aſſayed.

SECT. XV.

The piece of charcoal made uſe of in theſe experiments (Sect. vii.), muſt not be of a diſpoſition to crack. If this ſhould happen, it muſt gradually be heated until it does not crack any more, before any aſſay is made upon it. If this is not obſerved, but the aſſay made immediately with a ſtrong flame, ſmall pieces of it will ſplit off in the face and eyes of the aſſayer, and often throw along with them the matter that was to be aſſayed. Charcoal which is too much burnt conſumes too quick during the experiment, leaving ſmall holes in it, wherein the matter to be tried may be loſt: And charcoal that is burnt too little catches flame from the candle, burning by itſelf like a piece of wood, which likewiſe hinders the proceſs.

SECT.

SECT. XVI.

Of thofe things that are to be affayed, only a fmall piece muft be broke off for that purpofe, not bigger than that the flame of the candle (Sect. vii. xiv.) may be able to act upon it at once, if required; which is fometimes neceffary; for inftance, when the matter requires to be made red hot throughout. A piece of about an eighth part of an inch fquare is reckoned of a moderate fize, and fitteft for experiments; feldom more, but rather lefs. This proportion is only mentioned as a direction in regard to the quantity, the figure being of no confequence at all, a piece broke off from a ftone feldom or never happening to be fquare. But here it is to be obferved, that the piece ought to be broke as thin as poffible, at leaft the edges: The advantage thereof is eafily feen, the fire having then more influence upon the fubject, and the experiment being quicker made. This is particularly neceffary to be obferved when fuch ftones are to be affayed, which although in fome refpects fufible by themfelves, yet refift confiderably the action of the fire; becaufe they may by thefe means be brought into fufion, at leaft at their edges, which elfe would have been very difficult if the piece had been thick.

SECT. XVII.

Some of the mineral bodies are very difficult to keep fteady upon the charcoal during the experiment, before they are made red hot; becaufe, as foon as the flame begins to act upon them, they fplit afunder with violence, and difperfe. Such often

often are thoſe which are of a ſoft conſiſtence, or a particular figure, and which preſerve the ſame figure in however minute particles they are broke; for inſtance, the Calcareous Spar, the Sparry Gypſum, Sparry Fluor, White Sparry Lead-ore, the Potters Ore, (*Galena teſſellata*) the Teſſellated Mock-lead or Blende, &c. even all the common fluors which have no determinate figure, and moſt of the *Mineræ metallorum calciformes cryſtalliſatæ* or *ſpatoſæ*; All theſe are not ſo compact as common hard ſtones; and therefore, when the flame is immediately puſhed at them, the heat forces itſelf quickly through and into their clefts or pores, and cauſes this violent expanſion and diſperſion. Many of the clays are likewiſe apt to crack in the fire, which may be for the moſt part aſcribed to the humidity, of which they always retain a portion. Beſides theſe enumerated, there may be found now and then other mineral bodies of the ſame nature; but it is, however, not ſo common.

The only way of preventing this inconveniency, is to heat the body as ſlowly as poſſible. It is beſt, firſt of all, to heat that place of the charcoal, where the piece is intended to be put on, and afterwards lay it thereon; a little crackling will then enſue, but commonly of no great conſequence. After that, the flame is to be blown very ſlowly towards it, in the beginning not directly upon, but ſomewhat above it, and ſo approaching nearer and nearer with the flame until it becomes red hot. This will do for the moſt part; but there are nevertheleſs ſome, which, notwithſtanding all theſe precautions, it is almoſt impoſſible to keep on the charcoal. Thus the Fluors are generally the moſt difficult; and as one of their principal characters is diſcovered by their effects in the fire *per ſe*, (Sect. xviii. 6.) they ought neceſſarily

ceſſarily to be tried that way. To this purpoſe it is beſt to make a little hole in the charcoal to put the Fluor in, and then to put another piece of charcoal as a covering upon this, leaving only a ſmall opening for the flame to come in at, and to look at the proof. As this ſtone will nevertheleſs moſtly ſplit and fly about, a larger piece thereof than is before-mentioned, (Sect. xvi.) muſt be taken, in order to have at leaſt ſomething of it left.

But if the experiment is to be made upon a ſtone whoſe effects one does not want to ſee in the fire *per ſe*, but rather with fluxes, then a piece of it ought to be forced down into melted borax, (Sect. xxiii.) when always ſome part of it will remain in the borax, notwithſtanding the greateſt part may ſometimes fly away by cracking.

SECT. XVIII.

As the ſtones undergo great alterations when expoſed to the fire by themſelves, whereby ſome of their characteriſtics, and often the moſt principal, are diſcovered, they ought firſt to be tried that way; obſerving what has been ſaid before concerning the quantity of the matter, direction of the fire, &c. The following effects are generally the reſults of this experiment, viz.

1. Calcareous earth or ſtone, when it is pure, does never melt by itſelf, but becomes white and friable, ſo as to break freely between the fingers; and, if ſuffered to cool, and then mixed with water, it becomes hot, juſt as common quick lime. As in theſe experiments only very ſmall pieces are uſed, (Sect. xvi.) this laſt effect is beſt diſcovered by putting the proof on the outſide of the hand, with a drop of water to it, when inſtantly a very

quick

quick heat is felt on the ſkin. When the calcareous ſubſtance is mixed with the vitriolic acid, as in the gypſum; or with a clay, as in the marle; it commonly melts by itſelf; yet more or leſs difficult in proportion to the differences of the mixtures: The gypſum produces generally a white, and the marle a grey glaſs or ſlag. When there is any iron in it, as in white iron ore, it becomes dark, and ſometimes quite black, &c.

2. The Siliceæ never melt alone, but become generally more brittle after being burnt: Such of them as are coloured become colourleſs, and the ſooner when it does not ariſe from any contained metal; for inſtance, the Topazes, Amethiſts, &c. ſome of the precious ſtones, however, excepted. And ſuch as are mixed with a quantity of iron, grow dark in the fire, as ſome of the Jaſpers, &c.

3. The Garnet-kind melt always into a black ſlag, and that ſometimes ſo eaſy, that it may be brought into a round globule upon the charcoal.

4. The Argillaceæ, when pure, never melt, but become white and hard: The ſame effects follow when they are mixed with phlogiſton; for inſtance, the *Soap-rock* is eaſily cut with the knife; but, being burnt, it cuts glaſs, and would ſtrike fire with the ſteel, if as large a piece, as is neceſſary for that purpoſe, could be tried in this way. The *Soap-rocks* are ſometimes found of a dark brown and nearly black colour, but become for all that quite white in the fire, as a piece of China ware: However, care muſt be taken not to puſh the flame from the top of the wick, there being for the moſt part a ſooty ſmoke, which commonly will darken all that it touches; and if this is not obſerved, a miſtake in the experiment might eaſily happen: But if it is mixed with iron, as it is ſometimes found, it does not ſo eaſily part with

its dark colour. The Argillaceæ, when mixed with lime, melt by themſelves, as above-mentioned (1). When mixed with iron, as in the Boles, they grow dark or black; and if the iron is not in too great a quantity, they melt alone into a dark ſlag; the ſame happens, when they are mixed with iron and a little of the vitriolic acid, as in the common clay, &c.

5. The Micaceæ and Aſbeſtinæ become ſomewhat hard and brittle in the fire, and are more or leſs refractory, though they give ſome marks of fuſibility.

6. The Fluores diſcover one of their chief characteriſtics by giving a light, like Phoſphorus, in the dark, when they are ſlowly heated; but loſe this property, as well as their colour, as ſoon as they are made red hot: They commonly melt in the fire into a white opaque ſlag, though ſome of them not very eaſily.

7. Some ſorts of the Zeolites, a ſtone lately diſcovered, melt eaſily and foam in the fire, ſometimes nearly as much as Borax, and become a frothy ſlag, &c.

8. A great many of thoſe mineral bodies which are impregnated with iron, as the Boles, and ſome of the White Iron Ores, &c. as well as ſome of the other iron ores, viz. the Bloodſtone, are not attracted by the loadſtone before they have been thoroughly roaſted, &c.

A further digreſſion upon theſe effects is unneceſſary here, their enumeration belonging more properly to the Mineralogy; it is ſufficient only to have mentioned the moſt common, in order the better to explain the experiments that are made with the Blow-pipe.

SECT. XIX.

After the mineral bodies have been tried in the fire by themſelves, they ought to be melted with fluxes, to find out if they can be diſſolved or not, and ſome other phœnomena attending this operation. To this purpoſe three different kinds of ſalts are uſed as fluxes, viz. *Sal Sodæ*, *Borax*, and *Sal fuſible microcoſmicum* (Sect. xi).

SECT. XX.

The Sal Sodæ is a mineral alcali well known, prepared from the herb Kali or Saltwort; this ſalt is however not much uſed in theſe ſmall experiments, its effects upon the charcoal rendering it, for the moſt part, unfit for it; becauſe, as ſoon as the flame begins to act upon it, it melts inſtantly, and is almoſt wholly attracted by the charcoal. When this ſalt is employed to make any experiment, but a very little quantity thereof is wanted at once, viz. about the cubical contents of an eighth part of an inch, more or leſs: This is laid upon the charcoal, and the flame blown on it with the Blow-pipe; but as this ſalt commonly is in form of a powder, it is neceſſary to go on very ſoftly, that the force of the flame may not diſperſe the minute particles of the ſalt. As ſoon as it begins to melt it runs along on the charcoal almoſt as melted tallow, and when cold, it is a glaſſy matter of an opaque dull colour ſpread on the coal. The moment it is melted the matter which is to be tried ought to be put into it, becauſe otherwiſe the greateſt part of the ſalt will be ſoaked into the charcoal, and too little of it left for the intended purpoſe; the flame ought then to be directed on the matter itſelf, and if the ſalt ſpreads too much about, leaving the proof almoſt alone, it may be brought to it again by blowing the flame on its extremities, and directing it towards the ſubject of the experiment. In the aſſays made with this ſalt, it is true, we may find if the mineral bodies which are melted with it have been diſſolved by it or not; but we cannot tell with any certitude whether this is done haſtily and with force, or gently and ſlowly; whether only a leſs or a greater part of the matter has been diſſolved; nor can it be well diſtinguiſhed if the matter has imparted any weak tincture to the ſlag; becauſe this ſalt always bubbles upon the charcoal during the experiment, nor is it clear when cool; ſo that ſcarce any colour, except it be a very deep one, can be diſcovered, although it may ſometimes be coloured by the matter that has been tried.

SECT. XXI.

The other two ſalts, viz. the Borax, and the Sal fuſible microcoſmicum, are very well adapted to theſe experiments, becauſe they may by the flame be brought to a clear uncoloured and tranſparent glaſs; and as they have no attraction to the charcoal, they keep themſelves always upon it in a round globular form. The Sal fuſibile microcoſmicum is very ſcarce, and perhaps not to be met with in the ſhops; it is made of urine: Mr. Margraff has given a full account of its preparation in the Memoirs of the Academy of Sciences at Berlin.

SECT. XXII.

The quantity of theſe two ſalts required for an experiment is almoſt the ſame as the Sal Sodæ (Sect. xx.); but as theſe ſalts are criſtalliſed, and conſequently include a great deal of water, particularly the borax, their bulk is conſiderably reduced when melted, and therefore a little more of theſe may be taken than the before-mentioned quantity.

SECT. XXIII.

Both theſe ſalts, (Sect. xxi.) when expoſed to the flame of the Blow pipe, bubble very much and foam before they melt to a clear glaſs, but more ſo the borax, which for the moſt part depends on the water they contain: And as this would hinder the aſſayer to make due obſervations on the phœnomena of the experiment, the ſalt which is to be uſed, muſt firſt be brought to a clear glaſs, (Sect. xxi.) before it can ſerve as a flux; it muſt therefore be kept in the fire until it is become ſo tranſparent that the cracks in the charcoal may be ſeen through it. This done, whatſoever is to be tried, is put to it, and the fire continued.

SECT. XXIV.

Here it is to be obſerved, that for the aſſays made with any of theſe two fluxes (Sect. xxii.) on mineral bodies, no larger pieces of theſe muſt be taken, than that altogether they may keep a globular form upon the charcoal; becauſe then it may be better diſtinguiſhed in what manner the flux acts upon the matter during the experiment: If this is not obſerved, the flux, communicating itſelf with every point of the ſurface of the mineral body, ſpreads all over it, and keeps the form of this laſt, which commonly is flat, (Sect. xvi.) and by that means hinders the operator to obſerve all the phœnomena which may happen. Beſides, the flux being in too ſmall a quantity, in proportion to the body to be tried, is too weak to act with all its force upon it. The beſt proportion, therefore, is about a third part of the mineral body to the flux; and, as the quantity of the flux, mentioned in Sect. xx. xxii. makes a globe of a due ſize, in regard to the greateſt heat that is poſſible to procure in theſe experiments; the ſize of the mineral body, propoſed in Sect. xvi. required when it is to be tried in the fire by itſelf, is too large on this occaſion, the third part of it being here almoſt ſufficient.

SECT. XXV.

The Sal Sodæ, as has been ſaid before, is not of much uſe in theſe experiments; nor has it any particular qualities in preference to the two laſt mentioned ſalts, except that it diſſolves the Zeolites eaſier than the Borax and the Sal fuſibile microcoſmicum.

This laſt mentioned ſalt ſhews almoſt the ſame effects in the fire as the borax, and differs from this in very few circumſtances, of which one of the moſt principal is, that, when melted with mangameſe, it becomes of a crimſon hue, inſtead of a jacinth colour, which borax takes.

This ſalt is, however, for its ſcarcity, ſtill very little in uſe, borax alone being that which is commonly uſed. Whenever a mineral body is melted with any of theſe two laſt mentioned ſalts, in the above

above described manner (Sect. xxii. *et seq.)* it is easily seen whether it is quickly dissolved, because in that case an effervescence arises, which lasts till the whole is dissolved; or whether this is slowly done, in which case few and small bubbles only rise from the matter: Likewise, if it cannot be dissolved at all, because then it is observed only to turn round in the flux without the least bubble, and the edges look as sharp as they were before.

SECT. XXVI.

In order further to illustrate what has been said about these experiments, I will mention some instances out of the Mineralogy, concerning the effects of borax upon the mineral bodies, viz.

1. The calcareous substances, and all those stones which contain any thing of lime in their composition, dissolve readily and with effervescence in the borax: This effervescence is the more violent, the greater the portion of lime contained in the stone. This reason, however, is not the only one in the gypsum, because both the constituents of this do readily mix with the borax, and therefore a greater effervescence arises in melting gypsum with the borax, than lime alone.

2. The Siliceæ do not dissolve, unless some few, which contain a quantity of iron.

3. The Argillaceæ, when pure, are not acted upon by the borax; but when they are mixed with some heterogeneous bodies, they are dissolved, though very slowly; such is for instance the Stone Marrow, the Common Clay, &c.

4. The Granateæ, Zeolites, and Trapp, dissolve but slowly.

5. The Fluores, Asbestinæ, and Micaceæ, dissolve for the most part very easily, and so forth.

SECT. XXVII.

Some of these bodies melt to a colourless transparent glass with the borax; for instance, the Calcareous Substances, when pure, the Fluores, some of the Zeolites, &c. Others tinge the borax with a green transparent colour; viz. the *Granateæ*, *Trapp*, some of the *Argillaceæ*, some of the *Micaceæ* and *Asbestinæ*: This green has its origin, partly from a small portion of iron, which the *Granateæ* particularly contain, and partly from phlogiston.

SECT. XXVIII.

The borax cannot dissolve but a certain quantity of a mineral body proportional to its own: Of the calcareous kind it dissolves a vast quantity, but turns at last, when too much has been added, from a clear, transparent, to a white, opaque slag. When the quantity of the calcareous matter exceeds but little in proportion, the glass looks very clear as long as it remains hot; but as soon as it begins to cool, a white half opaque cloud is seen to arise from the bottom, which spreads over the third, half, or more of the glass globe, in proportion to the quantity of calcareous matter; but the glass or slag is nevertheless shining, and of a glassy texture when broke; if more of this matter be added, the cloud rises quicker and more opaque, and so by degrees till the slag becomes quite milk white: It is then no more of a shining, but rather dry appearance, on the surface; is very brittle, and of a grained texture, when broke.

SECT.

SECT. XXIX.

All that has been ſaid hitherto of experiments upon mineral bodies, is only concerning the ſtones and earths. I am now proceeding to the metals and ores, in order to deſcribe the manner of examining theſe bodies, and particularly the management of the Blow-pipe in theſe experiments. An exact knowledge, and nice proceeding are ſo much the more neceſſary here, as the metals are often ſo diſguiſed in their ores, as to be very difficultly known by their external appearance, and liable ſometimes to be miſtaken one for the other: Some of the cobalt ores for inſtance, reſemble much a Pyrites Arſenicalis; there are alſo ſome iron and lead ores, which are nearly like one another, &c.

SECT. XXX.

As the ores generally conſiſt of metals mineraliſed with ſulphur or arſenic, or ſometimes both together; they ought firſt to be expoſed to the fire by themſelves, in order, not only to determine with which of theſe they are mineraliſed, but alſo to ſet them free from theſe volatile mineraliſing bodies: Thus this ſerves inſtead of calcination, by which they are prepared for further eſſays.

SECT. XXXI.

Here it muſt be obſerved, that, whenever any metal, or fuſible ore is to be tried, a little concavity muſt be made in that place of the charcoal where the matter is to be put; becauſe, as ſoon as it is melted, it forms itſelf into a globular figure,

and

and might then roll from the charcoal, if its surface was plain; but when borax is put to it, this inconveniency is not so much to be feared.

SECT. XXXII.

Whenever an ore is to be tried, a small bit is broke off for that purpose, of such a size as is directed in Sect. xvi. this bit is laid upon the charcoal, and the flame blown on it slowly: Then the sulphur or arsenic begins to part from it in form of smoke; these are easily distinguished from one another by their smell, that of sulphur being sufficiently known, and the arsenic smelling like garlick. The flame ought to be blown very softly, as long as any smoke is seen to part from the ore; but, after that, the heat must be augmented by degrees, in order to make the calcination as perfect as possible. If the heat is applied very strong from the beginning upon an ore, that contains much of the sulphur, or arsenic, this ore will presently melt, and yet lose very little of its mineralising bodies, and by that means render the calcination very imperfect. It is however, impossible to calcine the ores in this manner to the utmost perfection, which is easily seen in the following instance, viz. in melting down a calcined Potter's ore with borax, it will be found to bubble upon the coal, which depends on the sulphur, which is still left, the vitriolic acid of this uniting with the borax, and causing this motion. However, lead in its metallic form, melted in this manner, bubbles alone upon the charcoal, if any sulphur remains in it. But, as the lead, as well as some of the other metals, may raise bubbles upon the charcoal, although they are quite free from the sulphur, only by the flames being forced too violently

lently on it, these phœnomena ought not to be confounded with each other.

SECT. XXXIII.

The ores being thus calcined, the metals contained in them may be discovered, either by being melted alone, or with fluxes: when they shew themselves, either in their pure metallic state, or by tinging the slag with colours peculiar to each of them. In these experiments it is not to be expected, that the quantity of metal contained in the ore should be exactly determined; this must be done in larger laboratories. This cannot, however, be looked upon as any defect, since it is sufficient for a mineralist, only to find out what sort of metal is contained in the ore. There is another circumstance, which I am sorry to say, is a more real defect in our little laboratory, which is, that some ores are not at all able to be tried in it, by so small an apparatus: for instance, the gold ore called *Pyrites aureus*, which consists of gold, iron, and sulphur. The greatest quantity of gold, which this ore contains, is about one ounce, or one ounce and an half out of one hundred pounds of the ore, the rest being iron and sulphur; and as only a very small bit is allowed for these experiments, (Sect. xvi. xxxi.) the gold contained therein, can hardly be discerned by the eye, even if it could be extracted, but it goes along with the iron in the slag, this last metal being in so large a quantity in proportion to the other, and both of them having a commicible power with each other.

All the kinds of Blende, Black jack, which are mineralised zink ores, containing zink, sulphur, and iron, cannot be tried this way, because they cannot be perfectly calcined, and besides, the zink

flies

flies off, when the iron ſcorifies: neither can all thoſe Blendes, which contain ſilver or gold mineraliſed with them, be tried in this manner, which is particularly owing to the imperfect calcination; nor are the quickſilver ores fit for theſe experiments, the volatility of this ſemi-metal making it impoſſible to bring it out of the poorer ſort of ores *; and the rich ores, which ſweat out the quickſilver, when kept cloſe in the hand, not wanting any of theſe aſſays, &c. Thoſe ores ought to be aſſayed in larger quantities, and even with ſuch other methods, as cannot be applied upon a piece of charcoal.

SECT. XXXIV.

Some of the rich ſilver ores are eaſily tried: for inſtance, *Minera argenti vitrea*, commonly called Silver-glaſs, which conſiſts only of ſilver and ſulphur. When this ore is expoſed to the flame, it melts inſtantly, and the ſulphur goes away in fume, leaving the ſilver pure upon the charcoal, in a globular form. If this ſilver ſhould happen to be of a dirty appearance, which often is the caſe, then it muſt be melted anew with a very little borax, and after it has been kept in fuſſion for a minute or two, ſo as to be perfectly melted and red-hot, the proof is ſuffered to cool: it may then be taken off the coal, and being laid upon the ſteel-plate, (Sect. xi. *n.*) the ſilver is ſeparated from the ſlag by one or two ſtrokes of the hammer (Sect. xi. *g.*). Here the uſe of the iron ring (Sect. xi.) is manifeſt, for this ought firſt to be placed upon the plate, to hinder the proof from flying off by the violence of the ſtroke, which otherwiſe would

* A piece of gold being laid over the proof, to receive the fumes, readily diſcovers if it contains any quick-ſilver. And it is probable, that by like proceſſes, we may alſo be enabled to diſcover with the Blow-pipe other of the volatile ſubſtances.

happen.

happen. The ſilver is then found incloſed in the ſlag of a globular form, and quite ſhining, as if it were poliſhed. When a large quantity of ſilver is contained in a lead ore, viz. in a potter's ore, it can likewiſe be diſcovered through the uſe of the blowpipe, of which more will be mentioned hereafter. (Sect. xxxix.)

SECT. XXXV.

Of the pure Tin ores, the tin may be melted out in its metallic ſtate. Some of theſe ores melt very eaſily, and yield their metal in quantity, if only expoſed to the fire by themſelves: but others are more refractory, and as theſe melt very ſlowly, the tin, which ſweats out in form of very ſmall globules, is inſtantly burnt to aſhes, before theſe globules have time to unite, in order to compoſe a larger globe, which might be ſeen by the eye, and is not ſo ſoon deſtroyed by the fire; it is therefore neceſſary to add a little borax to theſe from the beginning, and then to blow the flame violently at the proof. The borax does here preſerve the metal from being too ſoon calcined, and even contributes to the readier collecting of the ſmall metallic particles, which ſoon are ſeen to form themſelves into a globule of metallic tin at the bottom of the whole maſs, neareſt to the charcoal. As ſoon as ſo much of metallic tin is produced, as is ſufficient to convince the operator of its preſence, the fire ought to be ceaſed, although not the whole of the ore is yet melted; becauſe ſeldom, or rather never, the whole of this kind of ore can be reduced into metal by means of theſe experiments, a great deal thereof always being calcined: and if the fire is continued too long, perhaps even the metal, already reduced, may likewiſe be burnt to aſhes: for the tin is very ſoon deſtroyed from its metallic ſtate by the fire.

SECT.

SECT. XXXVI.

Moſt part of the lead ores may be brought to a metallic lead upon the charcoal. The *Mineræ plumbi calciformes*, which are pure, are eaſily melted into lead: but ſuch of them, as are mixed with an *ochra ferri*, or any kind of earth, as Clay, Lime, &c. yield very little of lead, and even nothing at all, if the heterogenea are combined therewith in any large quantity: this happens even with the *Minera plumbi calciformis arſenico mixta*. Theſe, therefore, are not to be tried but in larger laboratories. However, every mineral body ſuſpected to contain any metallic ſubſtance, may be tried by the blowpipe, ſo as to give ſufficient proofs, whether it contains or not, by its effects being different from thoſe of the ſtone or earths, &c.

SECT. XXXVII.

The *Mineræ plumbi mineraliſatæ*, leave the lead in a metallic form, if not too large a quantity of iron is mixed with it. For example, when a teſſellated or ſteel-grained lead ore is expoſed to the flame, its ſulphur, and even the arſenic, if there be any, begins to fume, and the ore itſelf immediately to melt into a globular form; the reſt of the ſulphur continues then to fly off, if the flame is blown ſlowly upon the maſs, inſtead of that, very little of the ſulphur will go off, if the flame is forced violently on it: in this caſe, it rather happens that the lead itſelf crackles and diſſipates, throwing about very minute metallic particles. The ſulphur being driven out, as much as poſſible, which is known by finding no ſulphureous vapour in ſmelling at the proof, the whole is ſuffered ſered to cool, and then a globule of metallic lead will be left upon the coal. If any iron is contained in the lead ore, the lead, which is melted out of it, is not of a metallic ſhining, but rather of a black and uneven ſurface: a little borax muſt in this caſe be melted with it, and as ſoon as no bubble is ſeen to riſe any longer from the metal into the borax, the fire muſt be diſcontinued: when the maſs is grown cold, the iron will be found ſcorified with the borax, and the lead left pure, and of a ſhining colour.

SECT. XXXVIII.

The borax does not ſcorify the lead in theſe ſmall experiments, when it is pure: if the flame is forced with violence on it, a bubbling will enſue, reſembling that which is obſerved when borax diſſolves a body melted with it, but when the fire ceaſes, the ſlag will be perfectly clear and tranſparent, and a quantity of very minute lead particles will be ſeen ſpread about in the borax, which have been torn off from the maſs during the bubbling.

SECT. XXXIX.

If ſuch a lead ore (Sect. xxxvii.) is rich in ſilver, this laſt metal may likewiſe be diſcovered by this experiment; becauſe, as the lead is volatile, it may be forced off, and the ſilver remain. To effect this, the lead, which is melted out of the ore, muſt be kept in conſtant fuſion with a ſlow heat, that it may be conſumed. This end will be ſooner obtained, and the lead part quicker, if, during the fuſion, the wind through the Blow-pipe is directed immediately, though not forcibly, upon the melted meſs itſelf, until it begins to cool, then the fire muſt be directed on it again. The lead, which is already in a volatilifing ftate, will by this artifice be driven out in form of a fubtil fmoke; and by thus continuing by turns, to melt the mafs, and then to blow off the lead, as has been faid, until no fmoke is any longer perceived, the filver will at laft be obtained pure. The fame obfervation holds good here alfo, which was made about the gold, that, as none but very little bits of the ores can be employed in thefe experiments, it will be difficult to extract the filver out of a poor ore; for fome part of it will fly off with the lead, and, what might be left, is too little to be difcerned by the eye. The filver, which, by this means is obtained, is eafily diftinguifhed from lead by the following external marks, viz. that it muft be red-hot, before it can be melted: it cooles fooner than lead: it has a filver colour; that is to fay, brighter and whiter than lead: and is harder to beat with the hammer. (Sect. xxxiv.)

SECT. XL.

The *Mineræ cupri calciformes*, (at leaft fome of them) when not mixed with too much ftone or earth, are eafily reduced to copper with any flux: if the copper is found not to have its natural bright colour, it muft be melted with a little borax, which purifies it. Some of thefe ores do not at all difcover their metal, if not immediately melted with borax; the heterogenea, contained in them, hindering the fufion, before thefe are fcorified by the flux.

SECT. XLI.

The grey Copper ores, which only confift of copper and fulphur, are tried almoft in the fame manner, as above-mentioned. (Sect. xl.) Being expofed expoſed to the flame by themſelves, they will be found inſtantly to melt, and part of their ſulphur to go off; the copper may afterwards be obtained in two ways: the one, by keeping the proof in fuſion for about a minute, and after ſuffering it to cool; when it will be found to have a dark and uneven appearance externally, but which, after being broke, diſcovers the metallic copper of a globular form in its centre, ſurrounded with a regule, which ſtill contains ſome ſulphur and a portion of the metal: the other, by being melted with borax, which laſt way ſometimes makes the metal appear ſooner.

SECT. XLII.

The *Mineræ cupri pyritaceæ*, containing copper, ſulphur, and iron, may be tried with the blow-pipe, if they are not too poor: in theſe experiments the ore ought to be calcined, and, after that, the iron ſcorified. For this purpoſe a bit of the ore muſt be expoſed to a ſlow flame, that as much of the ſulphur as poſſible may part from it, before it is melted, becauſe the ore commonly melts very ſoon, and then the ſulphur is more difficult to drive off. After being melted, it muſt be kept in fuſion with a ſtrong fire, for about a minute, that a great part of the iron may be calcined: and, after that, ſome borax muſt be added, which ſcorifies the iron, and turns with it to a black ſlag. If the ore is very rich, a metallic copper will be had in the ſlag, after the ſcorification: if the ore is of a moderate richneſs, the copper will ſtill retain a little ſulphur, and ſometimes iron: the product will therefore be brittle, and muſt with great caution be ſeparated from the ſlag, that it may not break into pieces; and if this product is afterwards treated in the ſame manner as before ſaid, in ſpeaking of the grey copper-ores (Sect. xli.), the metal will ſoon be produced. But, if the ore is poor, the product after the firſt ſcorification muſt be brought into fuſion, and afterwards melted with ſome freſh borax, in order to calcine and ſcorify the remaining portion of iron; after which it may be treated as mentioned in Sect. xli. The copper will, in this laſt caſe, be found in a very ſmall globule.

SECT. XLIII.

The copper is not very eaſily ſcorified with this apparatus, when it is melted together with borax; unleſs it has firſt been expoſed to the fire by itſelf for a while, in order to be calcined. When only a little of this metal is diſſolved, it inſtantly tinges the ſlag of a reddiſh-brown colour, and moſtly opaque; but as ſoon as this ſlag is kept in fuſion for a little while, it becomes quite green and tranſparent: and thus the preſence of the copper may be diſcovered by the colour, when it is concealed in heterogeneous bodies, ſo as not to be diſcovered by any other experiment.

SECT. XLIV.

If metallic copper is melted with borax by a ſlow fire, and only for a very little time, the glaſs, or ſlag, becomes of a fine tranſparent blue or violet colour, inclining more or leſs to the green; but this colour is not properly owing to the copper, but it may rather be to its phlogiſton; becauſe the ſame colour is to be had in the ſame manner from iron: and theſe glaſſes, which are coloured with either of theſe two metals, ſoon loſe their colour, if expoſed

posed to a strong fire, in which they are made quite clear, and colourless. Besides, if this glass, tinged blue with the copper, is again melted with more of this metal, it becomes of a good green colour, which for a long time keeps unchanged in the fire.

SECT. XLV.

The iron ores, when pure, can never be melted by themselves, through the means of the blow-pipe alone, nor do they yield their metal, when melted with fluxes, because they require too strong a heat to be brought into fusion; and, as both the ore and the metal itself very soon lose their phlogiston in the fire, and cannot be supplied with a sufficient quantity from the charcoal, so likewise they are very soon calcined in the fire. This easy calcination is also the reason why the fluxes, for instance borax, readily scorify this ore, and even the metal itself. The iron loses its phlogiston in the fire sooner than the copper, it is therefore easier scorified; and this is the principle on which the experiment mentioned in Sect. xlii. is founded.

SECT. XLVI.

The iron is, however, discovered without much difficulty, although it were mixed but in a very small quantity with heterogeneous bodies. The ore, or those bodies which contain any large quantity of the metal, are all attracted by the load-stone, some without any previous calcination, and others not till after having being roasted. When a clay is mixed with a little iron, it commonly melts by itself in the fire; but, if this metal is contained in a limestone, it does not promote the fusion, but gives the ſtone a dark, and ſometimes a deep black colour, which always is the character of iron. A *Minera ferri calciformis pura cryſtalliſata*, is commonly of a red colour: This being expoſed to the flame, becomes quite black, and is then readily attracted by the loadſtone, which it was not before. Beſides theſe ſigns, the iron diſcovers itſelf, by tinging the ſlag of a green tranſparent colour, inclining to brown, when only a little of the metal is ſcorified; but as ſoon as any larger quantity thereof is diſſolved in the ſlag, this becomes firſt a blackiſh brown, and afterwards quite black and opaque.

SECT. XLVII.

Biſmuth is known by its communicating a yellowiſh brown colour to borax: and Arſenic by its volatility, and garlick ſmell. Antimony, both in form of regulus and ore, is wholly volatile in the fire, when it is not mixed with any other metal (except arſenic), and is known by its particular ſmell; eaſier to be diſtinguiſhed, when once known, than deſcribed. When the ore of antimony is melted upon the charcoal, it bubbles conſtantly, during its volatiliſing.

SECT. XLVII.

Zinc ores are not eaſily tried upon the coal (Sect. xxxiii.). But the regulus of zinc, expoſed to the fire upon the charcoal, burns with a beautiful blue flame, and forms itſelf almoſt inſtantly into white flowers, which are the common flowers of zinc.

SECT. XLVIII.

Cobalt is particularly remarkable for giving to the glaſs a blue colour, which is the zaffre or ſmalt. To produce this, a piece of cobalt ore muſt be calcined in the fire (Sect. xxx. xxxi.) and afterwards melted with borax. As ſoon as the glaſs, during the fuſion, from being clear, ſeems to grow opaque, it is a ſign, that it is already tinged a little; the fire is then to be diſcontinued, and the operator muſt take hold with the nippers (Sect. xi. 6.) of a little of the glaſs, whilſt yet hot, and draw it out ſlowly in the beginning, but afterwards very quick, before it cools, whereby a thread of the coloured glaſs is procured, more or leſs thick, on which the colour may eaſier be ſeen againſt the day or candle-light, than if it was left in a globular form. This thread melts eaſily if only put in the flame of the candle, without the help of the blow-pipe.

If this glaſs is melted again with more of the cobalt, and kept in fuſion for a while, the colour becomes very deep; and thus the colour may be altered, according to pleaſure.

SECT. L.

When the cobalt ore is pure, or at leaſt contains but little iron, a cobalt regulus is almoſt inſtantly produced in the borax, during the fuſion: but when it is mixed with a quantity of iron, this laſt metal ought firſt to be ſeparated, which is eaſily performed, ſince it ſcorifies ſooner than the cobalt; therefore, as long as the ſlag retains any brown or black colour Sect. xlviii. it muſt be ſeparated, and melted again with fresh borax, until it shews the blue colour.

SECT. LI.

Nickel is very seldom to be had, and as its ores are seldom free from mixtures of other metals, it is very difficultly tried with the blowpipe. However, when this semi-metal is mixed with iron and cobalt, it is easily freed from these heterogeneous metals, and reduced to a pure nickel regulus by means of scorification with borax, in the same manner as is mentioned Sect. l. because both the iron and cobalt sooner scorify than the nickel. The regulus of nickel itself is of a green colour, when calcined: it requires a pretty strong fire before it melts, and tinges the borax with a jacint colour. Manganese gives the same colour to borax, but its other qualities are quite different, so as not to be confounded with the nickel.

SECT. LII.

Thus I have briefly described the use of the Blow-pipe, and the method of employing it in the study of Mineralogy. Any gentleman who is a lover of this science, will, by attending to the rules here laid down, be able in an easy manner to amuse himself in discovering the properties of those works of nature which the mineral kingdom furnishes us with. The husbandman may by its help find out what sorts of stones, earths, ores, &c. there are on his estate, and to what œconomical uses they may be employed. The Scientific Mineralist may, by examining into the properties and effects of the mineral bodies, discover the natural relation

relation these bodies stand in to each other, and thereby furnish himself with materials for establishing a Mineral System, founded on such principles as Nature herself has laid down in them; and this in his own study, without being forced to have recourse to great laboratories, crucibles, furnaces, &c. which is attended with a great deal of trouble, and is the reason why so few can have an opportunity of gratifying their desire of knowledge in this part of natural history. I do not pretend to say, that the Pocket-Laboratory here described, is in every respect as perfect as it is capable of being made: and I have in the foregoing pages indicated some instances where it is not sufficient; yet those instances are very few. Besides, the short time since it has been invented, and the few persons that have known how to make use of it, are a sufficient apology for its not being brought to the utmost degree of perfection. It is to be hoped, that the more general its use be made, the more and sooner will such imperfections be removed, and such wants filled up, as will be found necessary and convenient. I shall now add some hints towards these improvements, leaving to the judicious practitioner the manner of completing them.

SECT. LIII.

A greater number of fluxes might, perhaps, be found out, whose effects on mineral bodies might be different from these already in use, whereby more distinct characters of those mineral bodies might be discovered, which now either shew ambiguous ones, or which are almost impossible to try exactly with the Blow-pipe. Instead of the *sal sodæ*, some other salts might be found out, more fit for these experiments. But it is very necessary not to make uſe of any other fluxes than ſuch as have no attraction to the charcoal: if they, at the ſame time, are clear and tranſparent, when melted, as the borax and the *ſal fuſibile microcoſmicum*, it is ſtill better: however, the tranſparency or opacity are of no great conſequence, if a ſubſtance is eſſayed only in order to diſcover its fuſibility, without any attention to its colour; in which caſe, ſome metallic ſlag, perhaps, might be uſeful.

SECT. LIV.

When ſuch ores are to be reduced whoſe metals are very apt to calcine, ſuch as tin, zinc, &c. it might perhaps be of ſervice to add ſome phlogiſton, ſince the charcoal cannot afford enough of it in the open fire of theſe eſſays: ſuch a phlogiſton might be the hard reſin, or ſome ſuch body. The manner of melting the volatile metals out of their ores *per deſcenſum* might alſo, perhaps, be imitated: for inſtance, a hole might be made in the charcoal, wide above, and very narrow at the bottom; a little piece of the ore being then laid at the upper end of the hole, and covered with ſome very ſmall pieces of the charcoal, the flame muſt be directed on the top: the metal might, perhaps, by this method gather in the hole below, concealed from the violence of the fire, particularly if the ore is very fuſible, &c.

Several of my experiments have indeed induced me to believe the poſſibility of theſe improvements; but as I have not yet had an opportunity of bringing them to perfection, I will not deliver them as infallible: theſe hints are only communicated as an inducement to farther experience.

SECT.

SECT. LV.

The uſe of the Pocket-Laboratory, as here deſcribed, is chiefly calculated for a travelling mineraliſt. But a perſon who is always reſiding at one and the ſame place, may by ſome ſmall alteration make it more commodious to himſelf, and avoid the trouble of blowng with the mouth. For this purpoſe he may have the Blow-pipe go through a hole in a table, and fixed underneath to a ſmall pair of bellows with double bottoms, ſuch as ſome of the glaſs-blowers uſe, and then nothing more is required, than to move the bellows with the feet during the experiment; but in this caſe a lamp may be uſed inſtead of a candle. This method would be attended with a ſtill greater advantage, if there were many ſuch parts as fig. 3. tab. 1. the openings of which were of different dimenſions: theſe parts might by means of a ſcrew be faſtened to the main body of the Blow-pipe, and taken away at leiſure. The benefit of having theſe nozzles, if I may be permitted to call them ſo, of different capacities at their ends, would be that of exciting a ſtronger or weaker heat as occaſion might require. It would only be neceſſary to obſerve, that in proportion as the opening of the pipe (nozzle) is enlarged, the quantity of the flame muſt be augmented by a thicker wick in the lamp, and the force of blowing increaſed by means of weights laid on the bellows, A much intenſer heat would thus be procured by a pipe of a conſiderable opening at the end, by which the experiments might undoubtedly be carried farther than with the common Blow-pipe.

SECT. LVI.

A traveller, who has ſeldom an opportunity of carrying many things along with him, may very well be contented with this Pocket-Laboratory, and its apparatus, which is ſufficient for moſt part of ſuch experiments as can be made on a journey. There are, however, other things very uſeful to have at hand on a journey, which ought to make a ſecond part of the Pocket-Laboratory, if the manner of travelling does not oppoſe it: this conſiſts of a little box including the different acids, and one or two matraſſes, in order to try the mineral bodies in liquid menſtrua, if required.

SECT. LVII.

Theſe acids are, the Acid of Nitre, of Vitriol, and of Common Salt. Moſt of the ſtones and earths are attacked, at leaſt in ſome degree, by the acids; but the calcareous are the eaſieſt of all to be diſſolved by them, which is accounted for by their calcareous properties. The acid of nitre is that which is moſt uſed in theſe experiments; it diſſolves the limeſtone, when pure, perfectly, with a violent efferveſcence, and the ſolution becomes clear: when the limeſtone enters into ſome other body, it is nevertheleſs diſcovered by this acid, through a greater or leſs efferveſcence in proportion to the quantity of the calcareous particles, unleſs theſe are ſo few, as to be almoſt concealed from the acid by the heterogeneous ones. In this manner, a calcareous body, which ſometimes nearly reſembles a ſiliceous or argillaceous one, may be known from theſe latter, without the help of the Blow-pipe, only by pouring one or two drops of this acid

upon

upon the ſubject; which is very convenient when there is no opportunity, nor time, of uſing this inſtrument.

SECT. LVIII.

The Gypſa, which conſiſt of lime and the vitriolic acid, (Sect. xviii. 12.) are not in the leaſt attacked by the acid of nitre, if they contain a ſufficient quantity of their own acid, becauſe the vitriolic acid has a ſtronger attraction to the lime, than the acid of nitre: but if the calcareous ſubſtance is not perfectly ſaturated with the acid of vitriol, then an effervеſcence ariſes with the acid of nitre, more or leſs in proportion to the want of the vitriolic acid. Theſe circumſtances are often very eſſential in diſtinguiſhing the *calcarei* and *gypſa* from one another.

SECT. LIX.

The acid of nitre is likewiſe neceſſary in trying the zeolites, of which ſome ſpecies have the ſingular effect to diſſolve with effervеſcence in the abovementioned acid; and within a quarter of an hour, or even ſometimes not until ſeveral hours after, to change the whole ſolution into a clear jelly, of ſo firm a conſiſtence, that the glaſs, wherein it is contained, may be reverſed, without its falling out.

SECT. LX.

If any mineral body is tried in this menſtruum, and only a ſmall quantity is ſuſpected to be diſſolved, though it was impoſſible to diſtinguiſh it with the eye during the ſolution, it can be eaſily diſcovered

by

by adding to it *ad ſaturitatem* a clear ſolution of an alcali, when the diſſolved part will be precipitated, and fall to the bottom. For this purpoſe the *ſal ſodæ* (Sect. xx.) may be very uſeful.

SECT. LXI.

The acid of nitre will ſuffice for making experiments upon ſtones and earths; but if the experiments are to be extended to the metals, the other two acids (Sect. lvii.) are alſo neceſſary. As the acids are very corroſive, they muſt not be kept in the ordinary Pocket-Laboratory, already deſcribed, for fear of ſpoiling the other apparatus, if the ſtoppers ſhould happen not to fit exactly to the necks of the bottles, and ſome of the acid ſhould be ſplit.

SECT. LXII.

I have a ſeparate box, which is eight inches and three quarters long, four inches broad, and five inches high. In this box are three long and narrow bottles, containing the acids, placed upright at one end of it, two glaſs matraſſes laid horizontally in the upper part, and a little drawer underneath, made on purpoſe to fill the empty room below the matraſſes, and to give the box a regular form; and as charcoal is not every where to be met with in travelling, I always have a piece in this drawer for the uſe of the Blow-pipe.

SECT. LXIII.

In order to keep the acids more cloſe in the bottles, ſince the glaſs-ſtopper is not always ſufficient, I have a glaſs-cover beſides, made ſo, as to ſcrew round

round the neck of the bottle; and if this is nicely made, nothing can come through, though the box be inclined, or even reverſed, which ſometimes may happen. The natural form and bigneſs of the glaſs matraſſes is ſeen tab. 1, fig. 4. They ought to be very thin at the bottom, that they may not crack, by being ſuddenly put over the fire, or taken off it. In theſe matraſſes ſolutions may very eaſily be made over the flame of a candle: every mineral body capable of being affected by the acids in this degree of heat, may here be diſſolved, and particularly the metals. As the management in theſe proceſſes is the ſame as in ordinary laboratories, of which we have ample deſcriptions in ſeveral books, it is not neceſſary to copy them here, my intention being only to deſcribe an eaſy way of making experiments upon mineral bodies, which has not before been publiſhed; in explaining of which I nevertheleſs have been forced now and then to mention ſomething that more properly belongs to Mineralogy.

SECT. LXIV.

Another inſtrument is likewiſe neceſſary to a complete Pocket-Laboratory, viz. a Waſhing-trough, in which the mineral bodies, and particularly the ores, may be ſeparated from each other, and from the adherent rock, by means of water.

This trough is very common in the laboratories, and is uſed of different ſizes; but here only one is required of a moderate ſize, ſuch as twelve inches and a half long, three inches broad at the one end, and one inch and a half at the other end, ſloping down from the ſides and the broad end to the bottom, where it is three quarters of an inch deep: I have given a figure of it in tab. 1. fig. 5. It is com-

commonly made of wood, which ought to be chosen smooth, hard and compact, wherein are no pores in which the minute grains of the pounded matter may conceal themselves.

It is to be observed, that if any such matter is to be washed, which is suspected to contain some native metal, as silver or gold; a trough should be procured for this purpose, of a very shallow slope, because the minute particles of the native metal have then more power to assemble together at the broad end, separate from the other matter.

SECT. LXV.

The management of this trough, or the manner of washing, which I suppose to be known before, consists chiefly in this: That when the matter is mixed with about three or four times its quantity of water in the trough, this is kept very loose between two fingers of the left hand, and some light strokes given on its broad end with the right, that it may move backwards and forwards, by which means the heaviest particles assemble at the broad and upper end, from which the lighter ones are to be separated by inclining the trough and pouring a little water on them. By repeating this process, all such particles as are of the same gravity may be collected together, separate from those of a different gravity, provided they all were before equally pounded; though such as are of a clayish nature, are often very difficult to separate from the rest, which, however, is of no great consequence to a skilful and experienced washer. The washing process is very necessary, as there are often rich ores, and even native metals, found concealed in earths and sand in so minute particles, as not to be discovered by any other means.

F I N I S.

AN

ALPHABETICAL TABLE

OF DIFFERENT

MINERALS,

WITH THE

SWEDISH and GERMAN Names added thereto,

For rendering more easy the Knowledge of *Mineralogy*; a Subject treated of by some Writers, who make Use of several original Terms taken from those Two Languages.

ACIDS, (mineral) *Sw.* Mineraliska Syror; *Germ.* Saure-Saltz; *or* Mineralische-Sauron. Section 120.

Acid of common salt, *Sw.* Kok-salt-syra; *Germ.* Koch-salz-saure. Sect. 127. Vid. Vitriolic.

Agates. The irregular nodules in which they are found, are called *Amorphi*, Page 69, in the note.

Argillacea (terra) Sw. Ler-arter; *Germ.* Thon-arten. Sect. 77.

Alabastrites, *Sw.* Strat-gips. Sect. 17.

Alcali, *(Sal) Sw.* Alcaliska.

Alcali of the Sea, *Sw.* Haf's Salt's Alkali. Sect. 136.

Alkaline mineral salts, *Germ.* Mineralische-laugen Salter. Sect. 135.

Alum, *Sw.* Alun; *Germ.* Alaun.

Common Alum ore, *Sw.* Vanlig alum malm; *Germ.* Gemines alaun erts. Sect. 124. *C.*

Alum like Vitriol, *Germ.* Galitzenstein. Sect. 231, p. 219.

Alumen plumosum, Sw. Gedigen-alun; *Germ.* Fieder-alaun, *or* Gediegner-alaun. Sect. 124, *B.* 2. *a.*

Minera aluminis alba, Sw. Hvit-alun malm; *Germ.* Weises alaun erts.

Y Amber

[To follow Page 318]

Granite,

Lac

Metals.

Porphyry,

N. B. The POCKET LABORATORIES for Mineralogical Experiments, mentioned in the Note at Page 283, are still to be had at the same general Office, lately removed from *Wood-street*, *Cheapside*, to the Shop of Mr. *W. Brown*, Bookseller, at the Corner of *Essex-Street*, in the *Strand*, near *Temple-Bar*, *London*.

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